Introduction to the papers of TWG20: Mathematics teacher knowledge, beliefs, and identity: Some reflections on the current state of the art

Miguel Ribeiro, Fatma Aslan-Tutak, Charalambos Charalambous, Julia Meinke

Introduction to the papers of TWG20: Mathematics teacher knowledge, beliefs, and identity: Some reflections on the current state of the art

Miguel Ribeiro[1], Fatma Aslan-Tutak[2], Charalambos Charalambous[3] and Julia Meinke[4]

1 Norwegian University of Science and Technology (NTNU), Trondheim, Norway, miguel.ribeiro@math.ntnu.no, cmribas78@gmail.com
2 Bogazici University, İstanbul, Turkey
3 University of Cyprus, Nicosia, Cyprus
4 Georg-August University of Göttingen, Göttingen, Germany

In this introductory chapter for the Thematic Working Group "Mathematics teacher knowledge, beliefs, and identity" (TWG20) at CERME9, we address the main issues discussed during our working sessions. We aim to provide a critical and broader view on the work being done, including the work undertaken at previous conferences, although not extensively. We also seek to take a new look at areas of potential improvement with regard to the focus of, discussion about, and problems inherent to research in the area of teacher knowledge, beliefs and identity, all with the goal of improving teacher education and practices. This paper brings to the forefront some critical features of this area of research and aims to contribute to the genesis of a new focus on our research and a new vision of our own roles as researchers and teacher educators.

Keywords: Teachers' knowledge, beliefs, identity, teacher practices.

INTRODUCTION

In considering possible theoretical and analytical perspectives with regard to teacher *knowledge, beliefs,* and *identity*, a long list emerges that includes different aspects and foci. Even so, having a TWG dedicated exclusively to these areas allows the simultaneous amplification and synthesis of such a list—both in depth and on a broader scale—in terms of theoretical and analytical approaches, as well as the goals of the research presented.

A broader and deeper view of the multitude of possible perspectives on teacher *knowledge, beliefs,* and *identity* is facilitated by an in-depth discussion of, and reflection on, different contexts, such as the variety of knowledge frameworks and conceptualizations among different teachers, evaluating versus understanding teacher knowledge, belief changes, and the existence of a mathematics teacher identity and its content. Focusing on the content and on the aims of such a multitude of approaches to these three areas, gives a deeper awareness of possible potentialities and misunderstandings within the area of mathematics education. The existence of a multiplicity of ways to perceive the same aspect is in itself a potential area for improving research (and education), and should also be a focus in order to better understand each of the three factors addressed in the TWG. The misunderstandings come, for example, from the different contexts and cultural heritage of the researchers themselves, which leads to the use of different interpretations of a notion (e.g., teacher knowledge) being linked with the aims of the research itself (e.g., understanding versus evaluating teacher knowledge). Examples are the discussions presented by Kuntze, Dreher, and Friesen (2015); Vasco, Climent, Escudero-Ávila and colleagues (2015); and Pizarro, Gorgorió, and Albarracín (2015) around teacher knowledge in different contexts and using different theoretical and analytical approaches. Overcoming such misunderstandings allows a broader view of the landscape, leading to a better understanding of where we are coming from and where we envisage going in the future. Obviously, diverse paths can be taken, and we

consider this beneficial; but the different ways such approaches can contribute to the end goal should always be explicitly considered.

The creation of a unified understanding of the work being developed around the three focuses of the TWG requires evidence of how the multiplicity of theoretical and analytical approaches might contribute to the ultimate end point — the (student) teachers' learning. Knowing where we are heading — as well as where we are coming from —, this introduction will present and reflect upon the core aspects discussed in the TWG, expanding upon the content of the papers included in the proceedings and the already developed work. We note that although theoretical and analytical perspectives are perceived as intertwined, and thus incapable of being considered as two disjointed sets, we opted to deal with them in separate sections for operational purposes. In doing so, we advocate the need for more careful attention to the importance of attending to different perspectives and the roles they can play in research (process, findings, recommendations, and implications). Additionally, the large predominance of current research focusing on teacher knowledge also influenced the discussions we elaborate on here.

With this introductory chapter, the work developed in the TWG (focus upon problematic and core aspects of/for discussion when working in the area of teacher *knowledge, beliefs,* and *identity*) is discussed with some clarifications, and we call attention to the need for a further step forward in research in this area and its impact on education. We will also discuss the possible structure of future research.

SOME CORE THEORETICAL ASPECTS

When looking at the theme of our TWG, three areas of study are considered to deeply influence teacher practices: *knowledge*, *beliefs,* and *identity*. These can be considered as the core of a teacher's practices, with each area influencing and being influenced by the others (Ribeiro & Carrillo, 2011a). In doing so, our aim was to shed some light on the paths that still need to be devised to allow for a better understanding of teachers' *beliefs, identity,* and *knowledge*.

Beliefs

When teachers became a focus of research, one of the first attributes studied was their beliefs (e.g., Pajares, 1992), along with the inconsistencies that could be found between discourse and practice. Afterwards, the interest shifted to the ways teachers change their beliefs, leading in turn to a change in their teaching methods and awareness of their own practices—all influenced by their own experiences as students (e.g., Ebbelind, 2015; Sayers, 2013). Going a step further, another relevant point addressed was the development of teacher awareness about how and why they teach what they teach (e.g., Schueler, Roesken-Winter, Weißenrieder et al., 2015), making this transparent through the analysis of beliefs and thus making change possible.

Although a large amount of research has focused on beliefs and their manifestations in teacher actions, questions, or answers (e.g., Ribeiro & Carrillo, 2011b; Sayers, 2013), it is important to consider in conjunction with this the competencies and practices of teachers. Although beliefs have been a focus of research for a long time, there remains a lack of information leading to better and deeper understandings of the role, impact, and connection between teacher beliefs and the remaining core aspects of mathematics teacher practices (e.g., Potari, Berg, Charalambous et al., 2013) in order to improve student learning, understanding, and results. When addressing research being done on teacher beliefs (as well as their *knowledge* and *identity*), a core aspect of discussion in the TWG was the need to re-emphasize the human aspect of mathematics in the classroom—humanizing without de-mathematizing. Such foci would bring mathematics to the front, and is one of the core ways to bring more consistency (both internal and external) to the area, eradicating the question "Where is the mathematics in this mathematics education research?".

Identity

In researching identity, the particular aspects focused on within this multifaceted notion must be made explicit. In particular, the transformations involved in moving from student to teacher have to be taken into consideration. And, in an intertwined manner, the changes that occur over time in teacher practices, goals, and levels of awareness must also be examined, especially because some authors argue this leads to the development of a teacher identity (e.g., Adler, Ball, Krainer, Lin, & Novotná, 2005). Assuming the existence of such an identity, research on its development must consider the need to move from dealing with mathematics as a scientific discipline (as it is traditionally presented at university) to understanding

it as primary and secondary school mathematics and the diversity of processes involved; or, in other words, teacher professional development as a learning process. In that process, the concept of teaching and its dynamic nature plays an essential role in the development of a mathematics teacher's identity (e.g., Rø, 2015). Thus, when attempting to contribute to the study of teacher identity development as a learning process, our own practices and knowledge as educators should also be examined (e.g., Mellone, Jakobsen, & Ribeiro, 2015; Superfine & Lin, 2014) in order to allow for placing the scientific discipline into a primary and secondary school context. Such inquiry can lead to an expansion of the notion of awareness as perceived by Mason (2002), taking into consideration the possible focus on differences and similarities between the identity of mathematics teachers and those of teachers of other disciplines. It is of special importance to consider the specificity of the content being taught and how that influences teacher identity, particularly when a teacher must teach several disciplines, as is often the case for elementary school teachers. This once more brings mathematics and its specificities in and for teaching to the front.

When thinking in terms of mathematics teacher identities, and considering research as a way of making us stop and think (Kilpatrick, 1981), some questions naturally emerged during discussion and reflection in the TWG. Some of these discussions and reflections are concerned whether identity is a self-concept, leading to a broader question about the concept of identity itself, particularly what identity is and what comprises it[1], as well as its dynamic versus static nature. Taking a broader view of our own practices as teacher educators and researchers (as if looking at our own work from a distance), the need is evident to address the importance and helpfulness of the concept of identity(ies), clarifying its content as well as its developmental process(es).

Knowledge

Research of teacher knowledge began, and in some cases remains, in the domain of identifying lack of knowledge—assuming a deficit. In order to overcome such a deficit perspective and, further, contribute to the creation of improved education (Potari et al., 2013), research should be done that works with teachers to develop and expand upon what they already know. Although the papers in the TWG mainly adopted this perspective, it is clearly one area where research, and a rethinking of the foci of such research, is still most needed. Thus, a step forward is still required when rethinking the foci to lead away from the deficit perspective and toward an understanding of what teachers know and how they know it (nature and type) (e.g., Fauskanger & Mosvold, 2015; Montes & Carrillo, 2015). This can then lead to the development of practices that enrich the levels of awareness and connections that contribute to improved education and, ultimately, practice. Bridging theory and practice is essential for such improvement, and core to building such bridges is defining the nature and goals of proposed tasks (e.g., Jakobsen, Ribeiro, & Mellone, 2014; Tirosh & Wood, 2008) for enhancing teacher acquisition of ideal knowledge that would allow them to foster fruitful mathematical understanding in their students.

A large number of teacher knowledge conceptualizations—visible in the different papers of this chapter—are grounded in Shulman's (1986) seminal work. The discussed conceptualizations also assume the Subject Matter Knowledge (SMK) and Pedagogical Content Knowledge (PCK) domains, but with different interpretations of its content. Such interpretations associated with the devised focus of attention lead the research being done in different directions. Examples of such are the Mathematical Knowledge for Teaching (MKT) (Ball, Thames, & Phelps, 2008); the Mathematics Teachers' Specialized Knowledge (MTSK) (Carrillo, Climent, Contreras, & Muñoz-Catalán, 2013), the Knowledge Quartet (KQ) (Rowland, Huckstep, & Thwaites, 2005) and the multi-layer model presented by Kuntze (2012). The use and development of such diverse conceptualizations can be perceived from one side as a richness of the field, and from another side as a constraint when discussing the core aspects of teacher knowledge. Such diversity contributes to enriching views on the content and factors that influence the development of teacher knowledge, contributing scaffolding for the necessary bridges to improving student results. But they can also be problematic from the viewpoint of the language used —the same wording with different meanings (Bardelle, 2010) — making it difficult to find a common ground when discussing the core aspects of teacher knowledge.

1 This same question can be asked concerning knowledge and many other concepts we work with and sometimes take for granted. Indeed, in a TWG focusing on teachers, this was one of the problems discussed (see part of the proceeding with TWG18 papers).

Although the conceptualizations of teacher knowledge have different points of views and foci, as well as different elements at their cores, what they all have in common is considering teacher knowledge as too complex to be examined on its own, as well as the impossibility of considering the different subdomains in an isolated manner. In that sense, the existences of subdomains are justified for analytical reasons — facilitating description and a deep understanding of teacher knowledge and practices. The subdomains are also considered to be a core element for devising and conceptualizing teacher education tasks that are focused on improving teacher knowledge and awareness (Jakobsen et al., 2014).

The existence of such a diversity of concepts of teacher knowledge, as well as the diversity of dimensions as core elements, is one of the reasons for the continued lack of consensus on what comprises ideal knowledge. In the TWG discussions, such lack of consensus led to reflection and research on a number of topics. These included the advantages and disadvantages of considering different subdomains in teacher knowledge conceptualizations (subdomains versus global knowledge); whether or not there is a need to measure teacher knowledge, and if so, how to best do so (effectiveness of instruments designed and the nature of the knowledge measured); the nature of the claims the researcher makes about teacher knowledge and the learning outcomes with such a foci of analysis (e.g., deficit, descriptive, understanding, measurement perspective); and the potentialities and constraints of each conceptualization in and for analyzing teacher practices.

SOME CORE ANALYTICAL AND CONTEXTUALIZED ASPECTS

In practice, the theoretical aspects focused on cannot and should not be taken separately from the analytical approaches considered. In that sense, in accordance with the different theoretical perspectives explored in this chapter's papers, a diversity of analytical approaches was used. Such diversity was linked not only to the different frameworks considered, but also to the specific aim of the particular research. In this section, rather than discussing the type and nature of the analytical approaches used in the papers (e.g., different nature of the case studies – what concerns the cases; different foci of analysis and instruments used; the nature of the research aim – evaluate or understand knowledge/practices, contribute for change, understand awareness), we will address and reflect upon some of the more crucial aspects that emerged when discussing research focused on teacher *knowledge*, *beliefs,* and *identity*, including sharing the processes and results.

One of the most pertinent topics is the content of analytical and contextualized aspects, commonly termed methods or methodology. On the one hand, this section should include the description, justification, and explanation of the methods used in the research (with or without an example of how they were used). On the other hand, it should also include other contextualized information that would allow the reader to better understand the hows and whys of the decisions made and the specific context in which these were made (minimizing misunderstandings). Although this has already been a topic of discussion in previous conferences (e.g., Potari et al., 2013), it still remains an underinvestigated area. In that sense, there are some essential, though often unmentioned, aspects needing to be addressed and taken into account when thinking and writing about analytical and contextualization options. Among these, we can consider aspects from (i) why a certain analytical process was chosen over any other, (ii) the particularities of the method used (e.g., taking into consideration the theoretical perspective used or developed), and (iii) the different analyses done (e.g., qualitative, quantitative, particular case study, or going beyond the particular case study).

With regard to (i), the reasons for selecting a certain analytical process must be made explicit, including not only justification for the process chosen, but also factors that led to the exclusion of other approaches. This allows for building common ground. Some of the aspects to take into account are the minimal requirements for writing about the analysis and results obtained so others effectively understand them and the degree of detail needed for describing the context, assumptions, and each theoretical perspective.

For (ii), the particularities of the specific analytical processes used and the implications of a descriptive versus analytical approach must be made clear. Such particularities and implications are linked with the potential for, or limitation of, work being done to impact education and steer toward a change in teacher *beliefs* and *knowledge*, allowing the development of teacher *identity*, and thus its impact in practice. See, for example, Ferreira and Ponte (2015) for teacher learning after a teaching experience or Zoitsakos,

Zachariades, and Sakonidis (2015) for teacher difficulties in conceptualizing and suggesting mathematically correct instructional practices for an issue at hand. With regard to different subdomains in teacher knowledge, the subdimensions one might encounter and their impact (potentialities and limitations) on research, as well as for education and practice, must be taken into consideration. For example, what impact would they have in the elaboration of mathematics teacher identities? How can they be used as a resource to conceptualize tasks for teacher education? How can they refine the theoretical concept assumed? Keeping these questions in mind would contribute to an awareness of the need for developing further both theoretical and/or analytical methods used as well as ways to bridge research and practice, explicitly fulfilling the already identified gap concerning the need for clarification of the context and analytical procedures.

Concerning the different focus and processes of analysis (iii), and its impact on future research and knowledge generated, at least two perspectives must be kept in mind. One is how to feed back the research findings to inform the theoretical and analytical framework(s) used/developed. The other concerns a focus on what aspects can be brought into the discussion in order to go a step beyond merely describing the particulars of the situation(s) under study. When aiming at taking a step forward through the research to have a more effective impact on education, practice, and ultimately on student learning and understanding (e.g., Ebbelind, 2015), the previously mentioned two components need to be assumed in an intertwined manner. Considering the need for such an intertwined approach leads to reinforcing the connections and filling the gaps between such dimensions. Such reinforcement, and the associated step forward, seem to be crucial to clarifying the role, impact, and importance of case studies and large qualitative studies in improving education and promoting a deeper understanding of what seems to happen, and why, in the context of each study.

Thus, a need exists to clarify the choices made in research, keeping in mind the requirement of a balanced way of doing so, considering the broad range of research foci and analytical processes—all while also being aware of the different information required and the results obtained.

CONCERNS, POSSIBILITIES, AND FUTURE NEEDS

There is a diversity of theoretical and analytical approaches in the chapter's papers associated with different contexts and research aims. In this introductory paper, our aim was not merely to address the issues discussed during the working sessions. Rather, starting from these and thinking backward, our foremost concern was the possible horizons we could envisage moving toward at that time. With such an approach, we hope to lead the reader to think and reflect on the role of the diversity, depth, lenses, and aims associated with each of these studies. In doing so, we ultimately hope to contribute to thinking outside of the box in order to break the chains that constrain us, which ultimately restrict the effective potential of the work being developed.

During the TWG discussion of the papers and possible content and structure for this introductory chapter, a lot of questions for future research emerged. This provides evidence of the need for more focused attention to the what, how, and why of what we do, leading to envisioning potential impacts of the work with teachers and students to foster a more literate and numerate society globally. In that sense, addressing the different aspects and foci of needs (theoretical, analytical, and of context) is essential in order to allow a broader impact on the work of teaching (rather than merely remaining with particular successful cases). Such needs are of a diverse nature and associated with different aims, and therefore are associated with different target groups. When analyzing the papers and the questions raised from its discussion (e.g., the need for emphasizing teacher potential rather than deficiencies; bringing teachers and the mathematical content to the front; attending to teacher voices in the research being done — see, for example, Takker, 2015; Toor & Mgombelo, 2015) reflection on the researcher's role in the research and education process arises. There is thus the need for rethinking our own role—our own beliefs, knowledge, and identity — in the research being developed. Have they influenced the choices made and, necessarily, the path followed and results presented? We must consider ourselves and the work we develop not only as part of the possible solution to the problems addressed, but also as part of the challenges.

Possible points of focus for future research can be, for example: (a) having a profound understanding of a specific mathematical content (its meaning — core aspects of its content, ways to measure/develop it, analytical approaches and its implications); (b) connect the mathematical content knowledge (e.g., university mathematics) to the mathematical knowledge in primary and secondary school (changes and impact on teacher education — including their educators); (c) meaningful communication among communities with different professional identities (communicate findings to practitioners and policy makers to steer change); (d) development of theoretical and analytical tools to break some of the chains that constrain us (leave the known space of solutions and bring novelty to theoretical and methodological aspects, both as objects of and for research).

Having an open mind, developing an awareness (Mason, 2002) to pay attention to granular aspects, and making connections to better perceive and understand the big picture allows us to take a further step toward freeing research from the description and interpretations of particular cases (even when quantitative research is considered).

ACKNOWLEDGEMENT

This paper has been partially supported by the Portuguese Foundation for Science and Technology (FCT), project code (UID/SOC/04020/2013).

REFERENCES

Adler, J., Ball, D., Krainer, K., Lin, F.-L., & Novotná, J. (2005). Reflections on an emerging field: Researching mathematics teacher education. *Educational Studies in Mathematics, 60*(3), 359–381.

Ball, D. L., Thames, M. H., & Phelps, G. (2008). Content knowledge for teaching: what makes it special? *Journal of Teacher Education, 59*(5), 389–407.

Bardelle, C. (2010). Interpreting monotonicity of functions: a semiotic perspective. In M. F. Pinto & T. F. Kawasaky (Eds.), *Proceedings of PME 34* (Vol. 2, pp. 177–184). Belo Horizonte, Brazil: PME.

Carrillo, J., Climent, N., Contreras, L. C., & Muñoz-Catalán, M. C. (2013). Determining Specialized Knowledge for Mathematics Teaching. In B. Ubuz, Ç. Haser, & M. A. Mariotti (Eds.), *Proceedings of CERME8* (pp. 2985–2994). Ankara, Turkey: Middle East Technical University and ERME.

Ebbelind, A. (2015). Systemic Functional Linguistics as methodological tool when researching patterns of participation. In K. Krainer & N. Vondrova (Eds.), *Proceedings CERME9* (TWG20). Prague, Czech Republic: ERME.

Fauskanger, J., & Mosvold, R. (2015). Why are Laura and Jane "not sure"? In K. Krainer & N. Vondrova (Eds.), *Proceedings CERME9* (TWG20). Prague, Czech Republic: ERME.

Ferreira, N., & Ponte, J.P. (2015). Exploring pictorial representations in rational numbers: struggles of a prospective teacher. In K. Krainer & N. Vondrova (Eds.), *Proceedings CERME9* (TWG20). Prague, Czech Republic: ERME.

Jakobsen, A., Ribeiro, C. M., & Mellone, M. (2014). Norwegian prospective teachers' MKT when interpreting pupils' productions on a fraction task. *Nordic Studies in Mathematics Education, 19*(3–4), 135–150.

Kilpatrick, J. (1981). The Reasonable Ineffectiveness of Research in Mathematics Education. *For the Learning of Mathematics, 2*(2), 22–29.

Kuntze, S. (2012). Pedagogical content beliefs: global, content domain-related and situation-specific components. *Educational Studies in Mathematics*, *79*(2), 273–292.

Kuntze, S., Dreher, A., & Friesen, M. (2015). Teachers' Resources in Analysing Mathematical Content and Classroom Situations. In K. Krainer & N. Vondrova (Eds.), *Proceedings CERME9* (TWG20). Prague, Czech Republic: ERME.

Mason, J. (2002). Minding your Qs and Rs: Effective questioning and responding in the mathematics classroom. In L. Haggarty (Ed.), *Aspects of teaching secondary mathematics: Perspectives on practice* (pp. 248–258). New York, NY: Routledge Falmer.

Mellone, M., Jakobsen, A., & Ribeiro, C. M. (2015). Mathematics educator transformation(s) by reflecting on students' non-standard reasoning. In K. Krainer & N. Vondrova (Eds.), *Proceedings CERME9* (TWG18). Prague, Czech Republic: ERME.

Montes, M., & Carrillo, J. (2015). What does it mean as a teacher to "know infinity"? The case of convergence series. In K. Krainer & N. Vondrova (Eds.), *Proceedings CERME9* (TWG20). Prague, Czech Republic: ERME.

Pajares, F. M. (1992). Teachers' beliefs and educational research: Cleaning up a messy construct. *Review of Educational Research*, *62*(3), 307–332.

Pizarro, N., Gorgorió, N., & Albarracín, L. (2015). Primary teachers' approach to measurement estimation activities. In K. Krainer & N. Vondrova (Eds.), *Proceedings CERME9* (TWG20). Prague, Czech Republic: ERME.

Potari, D., Berg, C., Charalambous, C., Figueiras, L., Hošpesová, A., Ribeiro, et al. (2013). Group 17 – From a study of teaching practices to issues in teacher education: Introduction. In B. Ubuz, Ç. Haser, & M. A. Mariotti (Eds.), *Proceedings of CERME8* (pp. 2896–2907). Ankara, Turkey: METU and ERME.

Ribeiro, C. M., & Carrillo, J. (2011a). Knowing mathematics as a teacher. In M. Pytlak, T. Rowland, & E. Swoboda (Eds.), *Proceedings of CERME7* (pp. 2818–2826). Rzeszów, Poland: ERME.

Ribeiro, C. M., & Carrillo, J. (2011b). The role of beliefs and knowledge in practice. In B. Roesken & M. Casper (Eds.), *Current state of research on mathematical beliefs (MAVI 17)* (pp. 192–201). Bochum, Germany: Ruhr-Universität Bochum.

Rowland, T., Huckstep, P., & Thwaites, A. (2005). Elementary teachers' mathematics subject knowledge: The knowledge quartet and the case of Naomi. *Journal of Mathematics Teacher Education, 8*(3), 255–281.

Rø, K. (2015). Investigating mathematics teacher identity development: A theoretical consideration. In K. Krainer & N. Vondrova (Eds.), *Proceedings CERME9* (TWG20). Czech Republic: ERME.

Sayers, J. (2013). The influence of early childhood mathematical experiences on teachers' beliefs and practice. In B. Ubuz, Ç. Haser, & M. A. Mariotti (Eds.), *Proceedings of CERME8* (pp. 3247–3256). Ankara, Turkey: METU and ERME.

Schueler, S., Roesken-Winter, B., Weißenrieder, J., Lambert, A., & Römer, M. (2015). Characteristics of out-of-field teaching—teacher beliefs and competencies. In K. Krainer & N. Vondrova (Eds.), *Proceedings CERME9* (TWG20). Czech Republic: ERME.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15(2)*, 4–14.

Superfine, A.C., & Li, W. (2014). Exploring the Mathematical Knowledge Needed for Teaching Teachers. *Journal of Teacher Education, 65*(4), 303–314.

Takker, S. (2015). Confluence of research and teaching-Case study of a mathematics teacher. In K. Krainer & N. Vondrova (Eds.), *Proceedings CERME9* (TWG20). Czech Republic: ERME.

Tirosh, D., & Wood, T. (Eds.). (2008). *The International Handbook of Mathematics Teacher Education* (Vol. 2). Rotterdam, The Netherlands: Sense Publishers.

Toor, A., & Mgombelo, J. (2015). Teaching mathematics through storytelling-engaging the 'being' of a student in mathematics. In K. Krainer & N. Vondrova (Eds.), *Proceedings CERME9* (TWG20). Czech Republic: ERME.

Vasco, D., Climent, N., Escudero-Ávila, D., & Flores-Medrano, E. (2015). The Characterisation of the Specialised Knowledge of a University Lecturer in Linear Algebra. In K. Krainer & N. Vondrova (Eds.), *Proceedings CERME9* (TWG20). Czech Republic: ERME.

Zoitsakos, S., Zachariades, T., & Sakonidis, C. (2015). Secondary mathematics teachers' content knowledge for teaching in two contexts: interpreting versus managing didactically students' understandings. In K. Krainer & N. Vondrova (Eds.), *Proceedings CERME9* (TWG20). Czech Republic: ERME.