

# A Comparative Study of Finland and Chile: the Culture-Dependent Significance of the Individual and Interindividual Levels of the Mathematics-Related Affect

Laura Tuohilampi · Anu Laine ·  
Markku S. Hannula · Leonor Varas

Received: 24 June 2014 / Accepted: 22 February 2015 / Published online: 24 March 2015  
© Ministry of Science and Technology, Taiwan 2015

**Abstract** Mathematics-related affect is established regarding both individual and interindividual levels. However, the interaction between the levels has not been elaborated. Furthermore, it is known that people may draw either from intrinsic or extrinsic experiences to construct their identities depending on their cultural environment. Thus, affective individual and interindividual levels seem to interact with culture. In this study we focus on the significance of and the interaction between the individual and the interindividual levels of affect. This is done with respect to 2 different types of countries (Finland and Chile) to include cultural effect. We use questionnaire-based data and pupils' drawings of their mathematics class to find out about their individual and interindividual experiences. By using mixed data, we are not only getting a wider picture of pupils' affect but we can also avoid the most typical errors made in the cross-cultural comparisons as the pupils' own voice is strengthened. The main finding in the study is that the 2 affective levels are not congruent and that the incongruence appears differently in different types of cultures.

---

L. Tuohilampi (✉) · A. Laine · M. S. Hannula  
University of Helsinki, Helsinki, Finland  
e-mail: laura.tuohilampi@helsinki.fi

A. Laine  
e-mail: anu.laine@helsinki.fi

M. S. Hannula  
e-mail: markku.hannula@helsinki.fi

L. Varas  
University of Chile, Santiago, Chile  
e-mail: mlvaras@dim.uchile.cl

**Keywords** Collectivist cultures · Cultural comparison · Cultural significances · Individual cultures · Mathematics-related affect

## Introduction

In a number of studies, mathematics learning outcomes have been predicted solely by individual factors, such as motivation, self-beliefs, and emotions (Pajares & Miller, 1994; Greene, DeBacker, Ravindran & Krows, 1999; Ramirez, 2005; Mägi, Lerkkanen, Poikkeus, Rasku-Puttonen & Kikas, 2010). Yet, also other than purely individual factors, such as the social environment or the discourse in the class have importance. Class atmosphere has been connected with learning achievements empirically by Frenzel, Pekrun & Goetz (2007) and by Evans, Harvey, Buckley & Yan (2009). Class atmosphere seems to relate to the affect but not to the individual level of it. It looks like there is an interindividual level of affect which also impacts the students' learning process. However, Hannula (2011) have argued that compared with the individual level of affect, the interindividual level has much more rarely been examined.

As there are few studies about the interaction between the individual and the interindividual levels of mathematics-related affect levels (Chamberlin, 2010), there are open questions regarding them. Furthermore, we do not have an established definition about the interindividual level of affect regarding mathematics. Hannula (2011) have elaborated the social level of affect, clearly referring to the interindividual level, but in that examination, the focus was in how to study and theorize phenomena that exist across individuals. In Hannula (ibid.), the interindividual level of affect was represented through, e.g. learning environment (school, class) or family. However, the interindividual level also appears within the cultural norms and society, but differently, having different emphasis in different cultures (e.g. Evans, 2006; Markus & Kitayama, 1991; Earley, Gibson & Chen, 1999). It is argued that in collectivist cultures (see Markus & Kitayama, 1991), high performance connects with extrinsic motivation, wherein one is motivated because of external rewards or acknowledgments. In contrast, in the independent (also: ego-focused) cultures, intrinsic motivation connects to high performance: one learns well, if one learns because of personal and internal reasons, independent of possible extrinsic rewards. The extrinsic motivation is many times interpreted as more negative than intrinsic, however, this interpretation sees acknowledgement by significant others as something impure, which is an independent culture's point of view. From collectivist culture's point of view, the intrinsic motivation can show up as ego-central and foolish: in collectivist cultures, the extrinsic motivation can be seen as an orientation to learn *for* significant others rather than because of personal pleasure-oriented reasons, such as acknowledgments. Actually, in their broad examination of the self and the culture, Markus & Kitayama (1991) have challenged the whole idea of the universalism regarding self-development. They suggest that self-organization depends on the culture, and that even constructs that have been seen as thoroughly universal may differ essentially depending on

the culture. Consequently, it is possible that the significances of affective factors may differ essentially between the cultures.<sup>1,2</sup>

In this study, we aim to contribute to the field of mathematics-related affect by elaborating the interindividual level of and its interaction with the individual level, having the cultural level as a reference. The examination is done by looking at the congruence between what a pupil thinks about her/his individual affect and what she/he thinks about her/his interindividual level of the affect. The interindividual level of the affect is discussed with the help of 808 drawings concerning pupils' learning environment and by using earlier empirical and theoretical examinations. Moreover, as we will examine two OECD countries that are rated very differently by PISA studies (The Organisation for Economic Co-operation and Development (OECD), 2010b) and which situate on the different sides of the individualism-collectivism dimension (Hofstede & Hofstede, 2005), the culture's effect to the affect can be examined. The countries in question are Finland (individualist, independent selves) and Chile (collectivist, interdependent selves) (Hofstede & Hofstede, 2005; Markus & Kitayama, 1991).

## Theoretical Background

The affect can be discussed at different hierarchical levels (see Bronfenbrenner, 1993): in this study, we do this at the individual level (microlevel), at the interindividual level (meso and exo levels) and at the cultural level (macro level). On the individual level, we can distinguish the cognitive, emotional, and motivational affective factors (Hannula, 2011); also a distinction of the state and trait aspects of the affect is established at least at the individual level of affect (*ibid.*). On the interindividual level, we can talk about individuals' interaction with each other and about the significance of that to the individuals. On the broader cultural level, we can think of the surrounding culture and its significance to the other levels of the affect.

The individual and the interindividual level of the affect are separated in Hannula (2011) framework but considered to influence each other. Also, Evans (2006) argues that in the individual level, the affect is not discrete but socially organized. It draws from social norms, feedback, and shared meanings. In this study, this social basis in constructing the individual level affect is acknowledged. However, we see the individual level of affect as something personal, shared by the individual her/himself only, even if embedded on the social interaction. The interindividual level of affect, on the other hand, can be seen as drawing from the individuals' affective traits. The picture becomes even more complicated, if we accept that the interindividual affective indicators (see the discussion of belief indicators in Sumpter, 2012) may be

<sup>1</sup> In the previous PISA evaluation, the type of culture (collectivist/independent) seemed not to relate to the degree of correlation between mathematical achievement and intrinsic motivation, neither the degree of correlation between mathematical achievement and extrinsic ("instrumental") motivation. However, this might be explained by the fact that the correlation was categorically higher regarding students that were high achievers compared with lower-achieving students (OECD, 2010a), as the countries that achieved well in that PISA test had high correlations between both types of motivation and performance independent of the type of the countries' culture.

<sup>2</sup> The Gini index (or Gini ratio or Gini coefficient) is a measure of the inequality of income distribution in a country; a value of 0 expressing perfect equality where everyone has equal shares of income and a value of 1 expressing maximal inequality where only one person has all the income.

interpreted but not necessarily shared similarly by all the interpreters. For example, a group may be competitive in a way that all the group participants can recognize the competitive pressure “in the air,” yet not all the individuals personally have a similar amount of individual competitiveness (see Polychroni, Hatzichristou & Sideridis, 2011). All in all, within these assumptions, we hypothesize the relationship between the individual and the interindividual levels of the affect to be in a reciprocal interaction, affecting each other.

*The Individual Level of Affect.* In this study, the individual level of the affect refers to personal beliefs and conceptions (the cognitive dimension of the affect), emotions (the emotional dimension of the affect), and values and motives (the motivational dimension of the affect) (Hannula, 2011). *The cognitive dimension of individual affect* includes beliefs about the self, such as self-efficacy, self-competence, and self-confidence (ibid.). This dimension places itself under the affect, but refers to the affective features that can be evaluated regarding their truth value (c.f. Goldin, 2002). According to the arguments of Markus & Kitayama (1991), independent individuals see these attributes as something stable, as defining the individual. For interdependent individuals, such a determination through personal attributes is less meaningful and even less existing, as according to Markus & Kitayama (1991) the self-construal is dependent of a context. An interdependent person might be able to express lots of self-confidence, but once being in a situation where overt self-confidence would be regarded as socially inappropriate, she/he would act accordingly for the sake of harmony with the situation and the others. For an interdependent individual, the self is about how to act and react among others and not about what you would be without the others.

When it comes to *the emotional dimension*, Markus & Kitayama (1991) speak against the universalism across all the cultures. They suggest that for an independent individual, it is more natural to experience and express emotions that refer to the fulfillment or nonfulfillment of the personal goals, needs, or desires. Such emotions would be pride, frustration, and anger; these are labeled as *ego-focused* emotions. For an interdependent individual, it is more natural to experience and express emotions that refer to the fulfillment or nonfulfillment of the others’ needs and goals. Such emotions would, be e.g. sympathy or shame, and these emotions are labeled as *other focused* emotions.

*Motivation* in general reflects or consists of personal preferences and choices (Hannula, 2011). As motivation is volitional in nature, its truthfulness cannot be evaluated (Op’t Eynde, de Corte & Verschaffel, 2002). In motivation research, there are several theoretical approaches (e.g. Zhu & Leung, 2011). Here, we draw on the model presented in Hannula (2011), wherein the motivational dimension of the affect is in relation to the cognitive and emotional dimensions of the affect, with the dimensions all together formulating the structure of the affect. When it comes to the cultural differences, Markus & Kitayama (1991) argue that for the interdependent individuals, it is important to maintain harmony with others, whereas for the independent individuals, it is important to maintain intrinsic harmony. This means that others’ expectations would motivate interdependent individuals, and for independent individuals, it would be motivating to avoid internal discrepancies, such as desiring fluency with mathematics and still feeling incapable with the desire. Even further, for independent individuals such internal discrepancies would be harmful and might result in negative outcomes (Tuohilampi, 2011). Instead of working harder with mathematics, an independent

individual may end up decreasing the significance of the subject in order to minimize the internal discrepancy. An interdependent individual would not feel such internal discrepancy as painful; actually, according to Markus & Kitayama (1991), an interdependent person would not even experience such internal discrepancy in similar situations, as the focus would be on fitting in with others, not on internal feelings or desires.

*The Interindividual Level of Affect.* Though the affective structure is argued to constitute the cognitive, emotional, and motivational dimensions both on the individual and interindividual levels, the latter level is clearly less elaborated. Research on achievement goals has examined the role of the classroom goal structure (e.g. Kumar, Gheen & Kaplan, 2002). Another branch of research acknowledging both the individual and interindividual levels of the affect has documented the classroom microculture of the interactions between the teacher and the students. Evans et al. (2009) view the classroom atmosphere dividing it into three complementing components; (1) academic, referring to the pedagogical and curricular elements of the learning environment; (2) management, referring to discipline styles for maintaining order; and (3) emotional, the affective interactions within the classroom. Social interaction, as well as communication, can thus be seen as a part of academic and management components. At the same time, social interaction and structures, communication, and norms seem to relate to the cognitive and motivational part of the affective structure: they concern how the group acts and discusses, and these actions emerge from the socially shared motivation and ideals, originating from individuals' thoughts and actions. The class atmosphere relates to the emotional dimension, which might be independent of the motivational dimension, as it seems clear that the atmosphere is different in a very competitive group than in a noncompetitive group, while both may build up an enjoyable one though perhaps a different kind of emotional spirit. Furthermore, the social and sociomathematical norms are influenced by the more institutionalized school culture and broader sociocultural situation (Cobb & Yackel, 1996; Partanen, 2011). Finally, the classroom culture can mitigate the influence of the overall educational system on the students' motivational orientation (Ciani, Middleton, Summers & Sheldon, 2010).

*Cultural Level of the Affect.* Both levels of the affect are in many studies argued to be cultural constructs (Tuohilampi, Hannula, Varas, Giaconi, Laine, Näveri & Saló i Nevado, 2014b; Markus & Kitayama, 1991; Earley et al., 1999). In their deep examination of the culture and the self, Markus & Kitayama (1991) discuss the dissimilarities in the self-organization between groups that on average differ in their dependence on the others. As discussed earlier, in independent cultures the emphasis is on the importance of individualism and on differentiation from others. In interdependent cultures, the emphasis is on seeking harmony and not to differ from others. According to Hofstede & Hofstede (2005), cultures in general differ regarding their approximate degree of individualism vs. collectivism. In their study, Hofstede & Hofstede (2005) have stated the two countries referred in this study to be on the different sides of the individualism-collectivism dimension, with Finland being on the individualist and Chile on the collectivist end of the dimension (see a discussion about the differences and the similarities of Finland and Chile in Tuohilampi, Laine & Hannula, 2014a, Tuohilampi et al., 2014b).

In literature (Markus & Kitayama, 1991; Wagner & Moch, 1986), it has been suggested that in the collectivist cultures, group-referred feedback is more important in forming self-related beliefs, while personal feedback has more emphasis in the individual cultures. Even more nuanced, Earley et al. (1999) propose that while the individual cultures draw from personal feedback when forming self-beliefs, the collectivist cultures draw from both personal- and group-based feedback. The interesting question is whether the affect structure even consists similarly in different cultures: at least a recent study of Tuohilampi et al. (2014a, b) suggested that the whole factor structure was dissimilar at the individual level regarding independent individuals vs. collectivist individuals. Also, Bofah & Hannula (2015) have found that the same instrument of mathematics-related affect produced different factor structures when it comes to upper secondary students in Finland and Ghana.

As culture seems to impact the overall affect structure, an enlargement of the affective structure discussion is needed. Here, we hypothesize that for the independent individual, it is the individual level of affect that is the most significant and coherent. For the collectivist individual, we hypothesize that it is the interindividual level that is the most significant and coherent. For example, it is typical of the children as young as our examinees (3rd graders) to be positive regarding their affect (e.g. Harter, 1999), but at the same time in previous comparison between Finnish and Chilean children, the individual level of affect was measured to be more positive among Finnish pupils (Tuohilampi et al., 2014a, b). We see this as a possible sign of Finnish pupils valuing more the individual level of affect; to the Chilean pupils, the interindividual level of affect might be more significant. In Table 1, we suggest a structure of the affect that include the cultural effect as a background variable.

In this study, we aim to contribute to the research of the mathematics-related affect by elaborating the individual and the interindividual level of the affect, by clarifying their interaction and by examining the culture's effect on that. We also wish to widen the picture of the interindividual level of the mathematics-related affect by providing an examination of its features. The exact research questions are:

1. What are the distributions of the individual level of mathematics-related affect (measured through a questionnaire) and the interindividual level of mathematics-related affect (measured through examinees' drawings about their mathematics classes)?
2. How do these distributions differ regarding two different types of culture, i.e. Western (represented by Finland) and Latin (represented by Chile)?

**Table 1** Restructuring the affective structure with reference to its levels

	Individual level	Interindividual level
Independent self-organization	Personal beliefs, emotions, and values in internal interaction, orientation to maintain internal consistency	Individual differentiation from others
Interdependent self-organization	Personal beliefs, emotions, and values in interaction with surrounding	Others' thoughts and expectations, orientation to fit in

3. What is the interaction between the two levels of the mathematics-related affect (the individual level and the interindividual level), and how does that interaction differ regarding the two different types of culture?
4. What features of the interindividual level of the mathematics-related affect are especially expressed in the drawings of the examinees' mathematics classes, and how do these features differ regarding two different types of culture?

## Methodology

The main purpose of this study is to acquire more knowledge about pupils' individual level and interindividual level regarding the mathematics-related affect. The effect of the culture is particularly of interest. We will find out the cultural effect by examining the congruence of a pupil's individual level of affect with the same pupil's interindividual level of affect with respect to two reference countries. In this study, pupils' self-related questionnaire answers represent the individual-level affect. The interindividual level of affect is interpreted through what a pupil expresses in a drawing regarding her/his learning environment and her/his significant others in mathematics class. The cultural effect is examined by making the analysis separately regarding both countries and by interpreting the messages in the drawings. The analysis of the drawings is further used to elaborate the interindividual level of the affect.

There are important differences in the Finnish and Chilean culture, socioeconomic development, and education systems. Chile has a high social inequity (it has one of the worst Gini indices in the world: 0.52 in 2009 compared with that of Finland: 0.27 in 2008). The inequity is mainly reinforced by a highly segregated educational system (Valenzuela, Bellei & De Los Rios, 2014). In the Chilean educational system, the minority of the schools are public and free of charge while in Finland almost all schools are of that type. The number of school hours per week in Finland is one of the lowest compared with other countries (23 h/week is the minimum at 3rd grade). In Chile, the number of school hours is the greatest in the group of OECD countries (38 h/week). In Finland, ty lessons in 3rd grade are about mathematics, while in Chile the number of mathematics lessons in 3rd grade is six per week. The primary teachers in Finland need to have the master's degree in education. The profession is fairly valued in Finland and the salaries are little above the country's medium. In Chile, the teachers have low salaries (approximately half of the OECD average), the master's degree is not required, and the students applying for the primary school teacher programs have a very low education on average (OECD, 2011).

*Data Collection.* The data used in this study was gathered within a recent research project that aimed at develop mathematics learning in Finland and Chile (see further description of the project in Laine et al., 2012). In Finland, the number of participants was 466, and in Chile 901, this makes the total number of participants 1367. In addition, the number of drawings included in this study was 808. However, not all pupils had drawn a picture or answered all the items on the questionnaire: the number of involved pupils (answered the questionnaire and drawn a picture) in Finland was

248, in Chile 364, 612 in total. The data was collected at the beginning of the academic year 2010–2011: September–October 2010 in Finland (regions near to Helsinki) and March–April 2011 in Chile (Santiago). The Chilean school year begins 6 months later than it does in Finland because of geographical (climatic) reasons, so the questionnaire was applied to 3rd graders that were in average 6 months younger in Chile than in Finland. The schools are fairly uniform in Finland (see OECD, 2010b, p. 87), but in Chile there are private, semi-private, and public schools, and there can be huge variation between schools (OECD, 2010b). The data from Chile was collected from all those three types of schools. On the whole, the data is representative to capital region pupils in both of the countries.

*Individual Level of Affect: the Questionnaire.* In the questionnaire used in this study, the following aspects of the affect were to be measured: the cognitive dimension, including self-competence (spice item: “I have made it well in mathematics”), self-confidence (“I am sure that I can learn math”), the difficulty of mathematics, referred to as DoM (Mathematics is difficult”); the emotional dimension, including the enjoyment of mathematics, referred to as EoM (“I have enjoyed pondering mathematical exercises”); and the motivational dimension, including mastery goal orientation, referred to as MGO (“On every lesson, I try to learn as much as possible”); and behavior, including effort (“I always prepare myself carefully for exams”). The purpose of the instrument was to catch the trait aspect of affect. The instrument was a shortened and simplified version from the instrument used in Hannula & Laakso (2011), Tuohilampi (2011), and Hannula (2011) to measure 4th-grade Finnish pupils. The items were originally formulated in either English or Finnish and the translation was done into both languages, Finnish and Spanish. The measurement was done using a 3-point Likert scale (“true,” “partly true,” “not true”). Having pupils as young as 9-year old, the use of only 3 points makes the instrument simpler. The scale is an ordinal scale, as the middle option, “partly true,” may situate differently between the two ends depending on the examinee.

According to Op’t Eynde et al. (2002), beliefs become from what is “first told”. This means, that if there is nothing in contradiction to the given information (true or false), children tend to take it as true. This is in line with the developmental studies of Harter (1999), wherein it is shown that at first there is a general view of the self, typically an unrealistically positive one. However, around the age of 9, pupils ought to be at the level of understanding both the positive and negative parts of the appearance and presentation (Me and I selves) (Harter, 1999). As the Chilean sample constitutes of approximately half a year younger pupils, it is thus possible that among Chilean pupils, the degree of affect may be more positive. Markus & Kitayama (1991) discuss studies, where it is shown that even infants act differently regarding some of their mothers’ expressions, which they could see as a sign of different actions caused by culture. Thus, the cultural effect should be available among the examinees of age 9.

Before starting the analysis of the individual-level data, we considered whether all the affective factors measured in the questionnaire should have been analyzed separately. However, the questionnaire as a whole provided as much information as the separate factors would have done: the differences between the factors were minor. Thus, we constructed a sum variable of all the questionnaire items. The reliabilities (measured by Cronbach alpha’s) were satisfactory:  $\alpha = .895$  regarding Finnish pupils and  $\alpha = .833$  regarding Chilean pupils.

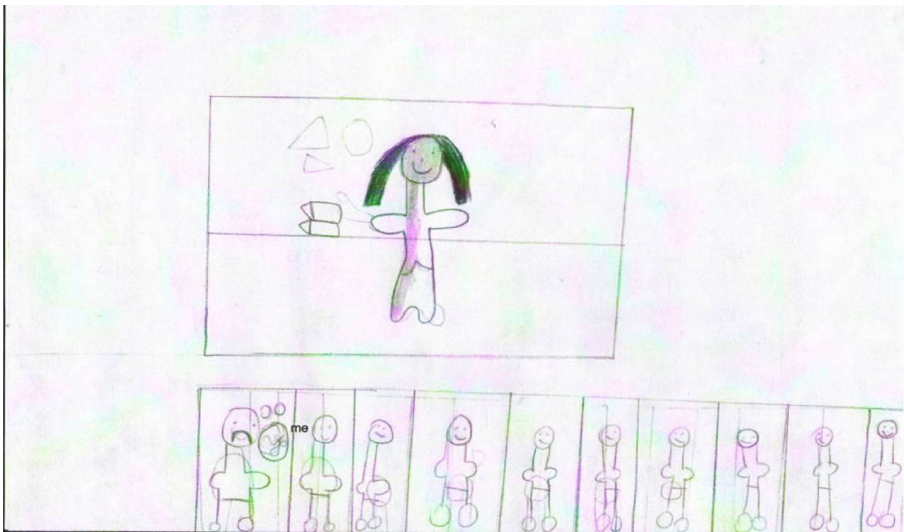


*Interindividual Level of Affect: the Drawings.* Many researchers (e.g. Aronsson & Andersson, 1996; Murphy, Delli & Edwards, 2004) have used pupils' classroom drawings, realizing that they form rich data to reach children's conceptions on teaching. Drawings can be used to find out latent emotional experiences (Kearney & Hyle, 2004). According to Harrison, Clarke & Ungeger (2007), drawings as indirect measurements tell more significantly about a pupil's accommodation to school than questionnaires and interviews. Also, Tikkanen (2008) and Dahlgren & Sumpter (2010) emphasize that one way to evaluate teaching is to use pupils' drawings about mathematics lessons.

The exact drawing task we gave to our examinees was "Draw your teaching group, the teacher and the pupils in a mathematics lesson. Use speech bubbles and thought bubbles to describe conversation and thinking. Mark the pupil who represents you in the drawing by writing ME." The teachers were instructed to give 45 min minimum to the pupils to complete their drawings. They were also instructed not to take a look at the drawings and to let the pupils know that. The pupils were allowed to draw only one moment in their drawings, but they were free to choose what moment to draw and what to emphasize. We interpreted facial expressions and speech expressed in drawings to represent the interindividual level of the pupils' affect. The coding was based on the "Classification of drawings" by Tikkanen (2008). In that classification, it was instructed to interpret the mouths of all the people in the drawing. In addition, written expressions in bubbles were included in the interpretation. Five categories were in use: positive (all the people were positive or neutral, and at least one person had mouth upwards or something positive was written), ambivalent (there were positive and negative people or writing in the drawing), negative (all the people were negative or neutral, and at least one person had mouth downwards or something negative was written), neutral (nothing could be inferred from persons' facial expressions or bubbles), and not recognizable (there were no people and no bubbles). Only few drawings went under the last category. As we started the coding, two of the researchers interpreted together 100 drawings. As there was zero unclearly interpreted drawings, and as the agreement rate between the coders in that subsample was 100 %, only one researcher coded the rest of the drawings. Of those, a few turned out to be to some extent unclear; these drawings were interpreted within the same research pair than at the beginning. At this phase, we found three drawings so confusing that we needed one more researcher to make an interpretation. Still, in general, the interpretation process was very straightforward. See Figs. 1 and 2 below to get an idea of the coding and an approximate clarity of the drawings.

To find out the situation considering our first research problem, we calculated the distributions of the pupils' individual (questionnaire-based) and interindividual (drawing-based) affects. The comparison was done separately for both countries: through this, we could find out the effect of culture to possible incongruence between the individual- and social-level affects (second research question).

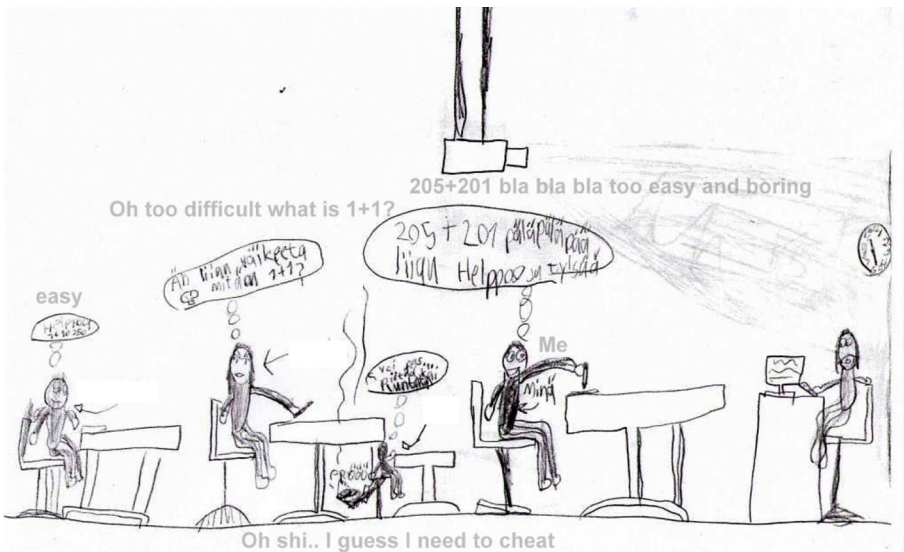
Two types of statistical tests were used in the comparison. First, a *t* test was in use for comparing the questionnaire answers regarding the countries. When drawing-based data was in use, a Chi-square test of dependence was in use. Chi-square test can be used only if the expected values are greater than zero in all cells and greater than 5 in more than 80 % of the cells. This was not the case in our data, so we could only calculate the Chi-square value with respect to partial data; for example, we calculated whether distributions of drawings differed between the countries when only categories *positive*,



**Fig. 1** A Chilean ambivalent drawing: one pupil’s mouth downwards, other pupils’ mouths upwards or neutral

*ambivalent, negative, and neutral* were taken into account, leaving *not recognizable* out of the test because of too small a frequency.

As we were interested in what was expressed in the drawings about possible differences between the cultures at the interindividual level of affect, we chose a sample of drawings for further investigation. The drawings that had been encoded as positive did not have much information, as all the people were just smiling or saying something nice. The drawings that were encoded as negative had at least someone looking sad or angry or saying something negative. This would have been interesting in some cases,



**Fig. 2** A Finnish ambivalent drawing: two pupils indicating the content easy; one pupil smiling; one pupil indicating the content difficult; one pupil indicating boredom; and one pupil swearing and farting

but the amount of the negative drawings was small. Neutrally encoded drawings did not include any positive nor negative information, and the drawings that were not recognizable were of course not informative. Consequently, drawings encoded as ambivalent were most informative: both positive and negative thoughts were present, as well as a contradiction. Thus, the ambivalent drawings became of interest. In both countries, there were enough ambivalent drawings. Yet, it was remarkable that in Chile the proportion of classes having less than 20 % ambivalent drawings was 90 % (this means that in whatever class, it was not typical that many pupils would have drawn an ambivalent drawing), while in Finland the proportion of classes having more than 20 % ambivalent drawings was 84 % (in whatever class, it was typical that a number of pupils had drawn an ambivalent drawing). From 19 Finnish classes, five classes having the biggest number of ambivalent drawings were chosen. From 21 Chilean classes, six classes were chosen on a similar vein. Consequently, 72 ambivalent drawings were selected: 38 Finnish pupils' drawings, 34 Chilean pupils' drawings. In Chile almost in every class, also in the ones that were chosen, clearly the greatest number of drawings were positive (e.g. 6 ambivalent, 27 positive, 5 neutral in one of the chosen classes). When it came to Finland, the number of positive drawings was not that remarkable among the chosen classes (e.g. 10 ambivalent, 6 positive, 1 neutral in one of the chosen classes).

We analyzed the reasons for ambivalence regarding the chosen drawings. This was done by thematic analysis. First, all the signs that referred to ambivalence were collected (e.g. someone is sleeping, another one is smiling; someone is succeeding, another one is failing). Second, we grouped the reasons (e.g. throwing erasers refers to making disturbances). Third, we labeled the groups (e.g. cheating/farting/chatting/teasing/shouting/shooting/homework undone/using cell phone + at least someone being positive → *Disturbance*). With the help of these categories and their content, plus the found differences between the countries, we discussed the research question number four.

## Results

We will begin with the distributions of the individual level of affect. We proceed to distributions of the interindividual level using the cultural level (the differentiation of the countries) as a reference (RQ 1 and 2). Then, we will connect the affective levels and see what the situation looks like when both levels and both cultures are included (RQ 3).

According to the *questionnaire*, the pupils' individual level of affect regarding mathematics is *mainly positive* in both countries (Table 2). Still, the proportion of pupils having the most positive affect is considerably greater in Finland than it is in Chile. Almost no pupils have negative affect in either of the countries, but in Chile there are more pupils in the middle category than there are in Finland. With respect to the distributions, there was a statistically significant difference according to *t* test between the countries ( $t = -6613$ ;  $p < 0.001$ ).

Regarding *the class atmosphere expressed in drawings* (Table 3), the pupils seem to be more negative in Finland. There, the proportion of positive drawings is clearly

**Table 2** The distributions regarding the individual level of the affect in Finland and Chile, measured by the questionnaire

Individual level of affect (%)	Positive	In between	Negative	Number
Finland	72.1	27.1	0.8	384 (100 %)
Chile	51.2	48.6	0.2	578 (100 %)

smaller than it is in Chile, and the proportions of ambivalent and negative drawings are greater in Finland than in Chile (Table 4). Regarding all the categories except not recognizable, the Chi-square test showed a statistically significant difference between the countries ( $\chi^2(3) = 99,500, p < 0.001$ ).

When comparing the atmosphere in the drawings (the interindividual level of affect) with what had been expressed in the questionnaire (the individual level of affect), the distributions in Finland seem to be quite similarly independent of the content of the drawing (see Table 5). This was confirmed by a Chi-square test regarding all the categories excluding the *negative* category of the questionnaire, plus the not recognizable category of the drawings: the Chi-square test indicated no statistically significant dependency between the questionnaire and the drawing frequencies among Finnish pupils ( $\chi^2(3) = 1372, p > 0.05$ ). In Chile, the situation was similar according to the Chi-square test ( $\chi^2(3) = 3627, p > 0.05$ ). Thus, the two levels of affect were statistically independent regarding both countries.

Summing up the results of the cross table above, in Finland many pupils think that they personally can do mathematics; they like it, they are confident with it, and they want to learn it. Still, they feel more uncertain about their learning environment than do pupils in Chile. In Chile, pupils seem to enjoy their class atmosphere and yet have less positive individual affective situation. This goes in line with our hypothesis: for Finnish pupils, the individual level of affect, which should be the more significant one, is more positive; for Chilean pupils, the interindividual level, which should be more significant, is more positive. The interaction between the individual and interindividual levels of the affect seems to be minimal, and according to these results, the levels are independent.

*Content Analysis of the Drawings.* In the thematic analysis of the drawings, we found a number of categories regarding the ambivalence. There were four categories present in both countries: *Easy and difficult* (somebody can + somebody cannot; 23 Finnish, 10 Chilean drawings); *Disturbance* (noise + teacher shouting "silence!"/cell phones/homework undone/throwing erasers/teasing/farting/cheating/unwillingness to do what

**Table 3** Distributions regarding the interindividual level of the affect in Finland and Chile, measured by the atmosphere in the drawings

Interindividual level of affect (%)	Positive	Ambivalent	Negative	Neutral	Not recognizable	Number
Finland	37.3	30.8	10.2	12.4	2.0	295 (100 %)
Chile	62.3	8.8	2.5	5.3	1.0	513 (100 %)

**Table 4** The interindividual level of the affect versus the individual level of the affect

	Questionnaire			Number
	Positive	In the middle	Negative	
<b>Finland</b>				
Positive atmosphere	76.9 %	23.1 %	0 %	100 %
	70	21	0	91
	38.5 %	33.3 %	0 %	
Neutral atmosphere	68.1 %	31.9 %	0 %	100 %
	32	15	0	47
	17.6 %	23.8 %	0 %	
Ambivalent atmosphere	71.4 %	25 %	3.5 %	100 %
	60	21	3	84
	33 %	33.3 %	100 %	
Negative atmosphere	76.9 %	23.1 %	0 %	100 %
	20	6	0	26
	11.0 %	9.5 %	0 %	
<i>N</i>	182	63	3	248
	100 %	100 %	100 %	
<b>Chile</b>				
Positive atmosphere	56.2 %	43.4 %	0.4 %	100 %
	132	102	1	235
	65.7 %	63.0 %	100 %	
Neutral atmosphere	50 %	50 %	0 %	100 %
	44	44	0	88
	21.9 %	27.2 %	0 %	
Ambivalent atmosphere	67.7 %	32.3 %	0 %	100 %
	21	10	0	31
	10.4 %	6.2 %	0 %	
Negative atmosphere	40 %	60 %	0 %	100 %
	4	6	0	10
	2 %	3.7 %	0 %	
<i>N</i>	201	162	1	364
	100 %	100 %	100 %	

**Table 5** Interaction and significances regarding the two levels of affect in Finland and Chile

Individual (interindividual)	
Finland	Good (ambivalent): the more meaningful level is better: intrinsic harmony, discrepancies in the less-significant level
Chile	Medium (good): the more meaningful level is better: harmony with others, discrepancies in the less-significant level

is asked; 22 Finnish, 7 Chilean drawings); *Boredom or sleepiness* (pupils saying “this is boring,” somebody is sleeping; 11 Finnish, 4 Chilean drawings); and *Positive and negative emotions* (typically someone smiling, another one with lips downwards; 10 Finnish, 4 Chilean drawings).

Four categories covered all the reasons for ambivalence within Finnish drawings. However, in Chilean drawings, we found two more categories. These were different phases or different loading (someone needs more time, another does not/someone wants more to do, another is exhausted; five Chilean drawings) and bizarre, hostile, or aggressive (e.g. shooting; five Chilean drawings). In addition, among Chilean drawings, we found three pictures that we could not include in any of the categories. In one class, two pupils had drawn a situation where the teacher was erasing something from the blackboard and the pupils resisted it: we could not recognize the origin of the disagreement in these cases. The third drawing we could not include in any of the categories was about evaluating the lesson: one pupil seemed to like the lesson, while another one thought there something should have been done better; we could not identify whether the disagreement was emotive, academic, social, or something else.

The countries differed a bit regarding the categories and there were more categories in Chile. Furthermore, the classes were not as uniform in Chile as they were in Finland. In Finland, practically all categories were present in every class that was under examination. In Chile, there were classes where almost all the drawings expressed ambivalence because of only one or two reasons (categories). None of the Chilean drawings included all the categories at the same time, so the classes varied between each other more in Chile than in Finland (see Appendix 1 and Appendix 2). Another difference between the countries considered the category *disturbance*. In Finland, the disturbances targeted mostly the teacher, whereas in Chile this was not always the case: the target could be another pupil as well. Finally, in Chile, even in ambivalent pictures, there was a remarkable amount of positive small talk, smiling, and helping; this was not visible in Finnish drawings. All these notions are in line with our hypothesis: in Chile, the interindividual level varied more and the pupils expressed lots of things with reference to their surroundings, even complicated ones.

## Discussion

The examined pupils showed mainly positive affect through both tools, that is, through the questionnaire and through the drawings. Also, the children were mostly positive about their class atmosphere. These results are not surprising regarding the examinees' developmental stage (Harter, 1999).

Though the distributions were mainly positive regarding both levels of the affect, we found incongruence between the levels. Even more, the disparity was not similar with respect to both countries. In Finland, most pupils were happy with the individual level of affect, but less satisfied with the interindividual level of affect and the situation was opposite in Chile. This goes along with our hypothesis, as in both countries the level of the affect that was more positive was the one that ought to be culturally more significant for the self-organization (Markus & Kitayama, 1991). However, the incongruence implicates that different aspects of the affect might be available through different

methods or that different methods measure thoroughly different aspects of the affect. Whatever the situation, different kinds of results regarding the affect may follow depending on the tool; also, cultural differences might vary depending on the tool. It seems obvious that the use of more than one method is needed at least when trying to make a comparison between the cultures.

The thematic analysis of the selected drawings revealed altogether six categories concerning the ambivalence. These categories were not universal between the countries: in Finland, there were fewer categories than in Chile. As the four categories found within Finnish drawings were present practically in all the classes, it seems that the reasons for ambivalence across the classes are in Finland more uniform than it is in Chile: the ambivalence seems to appear similarly in all the classes in Finland. Regarding Chile, there were classes where the reasons for ambivalence varied across the classes, thus the culture across the classes differed, even though some of the classes were more uniform than the classes in Finland. The bigger amount of categories in Chile and more variation between the classes can be seen as an indicator to what has been presented by Markus & Kitayama (1991). They argue that interdependent individuals focus more on their social environment than do independent individuals. Also according to Earley, Gibson & Chen, (1999), in collectivist cultures both individual and social-related feedback is necessary. Thus, the ones that live in more collectivist cultures might be able to notice a different type of variation in their surroundings.

The two levels of the affect appeared independent in this study. Yet, it is possible that the interindividual level of the affect connects with the individual level of the affect in a more complicated way, e.g. over time. Speaking of the interindividual level of affect, the Chileans were clearly more positive than their Finnish counterparts. The categories found widen the picture showing that the pupils have participated in the other pupils' cognitive processes (easy and difficult), behavioral habits (disturbance), physically appearing emotions (boredom and sleepiness), and emotions expressed by facial expressions (positive and negative emotions). Chilean pupils have in addition been aware to other pupils' negative arousal emotions (bizarre, hostile, or aggressive). These emotions can be seen as ego focused, and also as other focused, as they can represent an intention to interrupt harmony. The last category, different phases or different loading among Chilean pupils seems to be the most difficult to connect with any particular affective factor. Is it that the drawers have noticed other pupils being physically exhausted, referring to emotions, or that other pupils have the different degree of challenge, thus referring to the cognitive processes?

Within our theoretical framework, none of the categories clearly refer to the motivational dimension of the affect. However, some of the categories could be connected with the individual level of motivation. For example, it seems unlikely that experiencing boredom or sleepiness on learning environment would not have an effect on the personal enthusiasm. On the other hand, boredom or sleepiness can be seen to indicate lack of motivation, thus referring to the motivational dimension of the affect at the interindividual level.

In Hannula's (2012) framework, the state aspect of the interindividual level of affect can be scrutinized through the social interaction, communication, and momentarily classroom atmosphere, and its trait aspect through norms, social structures, and nonmomentarily classroom atmosphere. This study examined the interindividual level of affect through the classroom atmosphere though the other aspects were considered

being part of it. Our perspective was in how the individuals expressed the atmosphere instead of evaluating it from the outside. The pupils' expressions can be seen to represent the state aspect (what happens at a particular moment), and also the trait aspect (the pupil chooses something that considers significant in general). Also, categories found in this study seem to refer both to the state and the trait aspects (e.g. boredom as a trait and sleepiness as a state) and they could be connected either to the cognitive factor (easy and difficult; different phases), to the emotional factor (boredom and sleepiness; positive and negative emotions; bizarre, hostile, or aggressive; different loading), or to the social interaction (disturbance). This makes the interindividual level of affect to consist at least of the experienced and expressed emotions, of the exposed and assumed demands of working, and of the ways people communicate. Consequently, we see that at least the cognitive and especially the emotional factors exist at the interindividual level of affect. Furthermore, we see that communication can connect with any of the affective dimensions (cognitive, emotional, and motivational). Communication can be seen as a tool for the individual's to express and experience the interindividual actions, but it can also be seen as something that creates the interaction and tunes the atmosphere. Following what has been presented according to the ambivalent drawings' categories, we suggest that the interindividual level of affect appears in the spoken and unspoken communication that connects with the cognitive, emotional, and motivational affective actions, experiences, and meanings of a group and its individual members.

In this study, the interaction between the individual and the interindividual level of the affect appeared fairly independent. Evans (2006) argued that individual affect draws from social interaction, however, our results suggest that this effect comes from somewhere else than from the class surrounding. Finnish pupils' individual level of affect was at good level despite the fact that many pupils experienced their learning environment ambivalent or even negative. Having in mind Finnish pupils' independent basis for self-organization, this is not a surprise. In Chile, the case can be different: the individual level of affect is on average lower than it is among Finnish pupils, but because of their interdependent, context-dependent basis of self-organization, this lower degree may be totally acceptable. Actually, it is even possible that this lower degree of the individual level of the affect is just a sign of the pupils not having constructed their individual selves, that being less significant. Thus, though the levels seemed to be independent in both countries, it seems like either the individual or the interindividual level of affect is more significant depending on the country (see Table 5).

This study has provided new clarifications to mathematics-related affect research by using multiple data. The study gives confirmation of the cultural basis of the affect. We suggest future studies to take this aspect into account to better succeed in understanding the affect and especially its relationship with performance. We see that the interindividual level of affect should be better considered in collectivist cultures, and the significance of affective levels should always be acknowledged. Also, the use of multiple data, mixed methods, and inside-culture approach can be recommended in cultural comparisons.



## Appendix 1

**Table 6** The distributions of the categories in the examined Chilean classes

Class	Easy + difficult	Disturbance	Different phases	Weird, hostile, aggressive	Boring, sleepy	Positive and negative emotions	Teacher erasing, pupils resist	Evaluating the lesson
1.	1	2	1	2	–	1	–	–
2.	–	3	2	–	1	–	–	–
3.	1	1	1	2	1	–	–	1
4.	3	–	–	–	–	2	2	–
5.	4	1	–	1	–	1	–	–
6.	1	–	1	–	2	–	–	–

## Appendix 2

**Table 7** The distributions of the categories in the examined Finnish classes

Class	Easy + difficult	Disturbance	Boring, sleepy	Positive + negative emotions
1.	5	2	3	1
2.	3	1	3	3
3.	1	6	4	1
4.	5	4	–	4
5.	9	9	1	1

## References

- Aronsson, K. & Andersson, S. (1996). Social scaling in children's drawings of classroom life: a cultural comparative analysis of social scaling in Africa and Sweden. *British Journal of Developmental Psychology*, *14*, 301–314.
- Bofah, E. A. T., & Hannula, M. S. (2015). Studying the factorial structure of Ghanaian twelfth-grade students' views on mathematics. In *From beliefs to dynamic affect systems in mathematics education* (pp. 355–381). Springer International Publishing.
- Bronfenbrenner, U. (1993). The ecology of cognitive development: Research models and fugitive findings. In R. H. Wozniak & K. W. Fisher (Eds.), *Development in context: Acting and thinking in specific environments* (pp. 3–44). Hillsdale, NJ: Erlbaum.
- Chamberlin, S. A. (2010). A review of instruments created to assess affect in mathematics. *Journal of Mathematics Education*, *3*(1), 167–182.
- Ciani, K. D., Middleton, M. J., Summers, J. J. & Sheldon, K. M. (2010). Buffering against performance classroom goal structures: the importance of autonomy support and classroom community. *Contemporary Educational Psychology*, *35*, 88–99.
- Cobb, P. & Yackel, E. (1996). Constructivist, emergent and sociocultural perspectives in the context of developmental research. *Educational Psychologist*, *31*(3/4), 175–190.

- Dahlgren, A. & Sumpster, L. (2010). Childrens' conceptions about mathematics and mathematics education. In: K. Kislenko (Ed.) *Proceedings of the MAVI-16 conference* (pp. 77–88). Estonia: MAVI
- Earley, P. C., Gibson, C. B. & Chen, C. C. (1999). How did I do?" versus "how did we do?". Cultural contrasts of performance feedback use and self-efficacy. *Journal of Cross-Cultural Psychology*, 30(5), 594–619.
- Evans, J. (2006). Affect and emotion in mathematical thinking. In J. Maasz & W. Schloeglmann (Eds.), *New mathematics education and practice* (pp. 233–255). Rotterdam, The Netherlands: Sense.
- Evans, I. M., Harvey, S. T., Buckley, L. & Yan, E. (2009). Differentiating classroom climate concepts: academic, management, and emotional environments. *New Zealand Journal of Social Sciences*, 4(2), 131–146.
- Frenzel, A. C., Pekrun, R. & Goetz, T. (2007). Perceived learning environment and students' emotional experiences: a multilevel analysis of mathematics classrooms. *Learning and Instruction*, 17(5), 478–493.
- Goldin, G. (2002). Affect, meta-affect, and mathematical belief structures. In G. Leder, E. Pehkonen & G. Törner (Eds.), *Beliefs: a hidden variable in mathematics education?* (pp. 59–72). Dordrecht, The Netherlands: Kluwer.
- Greene, B. A., DeBacker, T. K., Ravindran, B. & Krows, A. J. (1999). Goals, values, and beliefs as predictors of achievement and effort in high school mathematics classes. *Sex Roles*, 40(5/6), 421–458.
- Hannula, M. (2011). The structure and dynamics of affect in mathematical thinking and learning. In M. Pytlak, T. Rowland & E. Swoboda (Eds.), *Proceedings of the Seventh Congress of the European Society for Research in Mathematics Education* (pp. 34–60). Rzeszów, Poland: ERME.
- Hannula, M. S. (2012). Exploring new dimensions of mathematics-related affect: embodied and social theories. *Research in Mathematics Education*, 14(2), 137–161.
- Hannula, M. S., & Laakso, J. (2011). The structure of mathematics related beliefs, attitudes and motivation among Finnish grade 4 and grade 8 students. In Proceedings of the 35th Conference of the International Group for the Psychology of Mathematics Education, Vol. 1, Ankara, Turkey: PME.
- Harrison, L. J., Clarke, L. & Ungerer, J. A. (2007). Children's drawings provide a new perspective on teacher-child relationship quality and school adjustment. *Early Childhood Research Quarterly*, 22, 55–71.
- Harter, S. (1999). *The construction of the self. A developmental perspective*. New York, NY: The Guilford Press.
- Hofstede, G. & Hofstede, G. J. (2005). *Cultures and organizations*. New York, NY: McGraw-Hill.
- Kearney, K. S. & Hyle, A. (2004). Drawing about emotions: the use of participant-produced drawings in qualitative inquiry. *Qualitative Research*, 4(3), 361–382.
- Kumar, R., Gheen, M. H. & Kaplan, A. (2002). Goal structures in the learning environment and students' disaffection from learning and schooling. In C. Midgley (Ed.), *Goals, goal structures, and patterns of adaptive learning* (pp. 143–173). Mahwah, NJ: Erlbaum.
- Laine, A., Näveri, L., Pehkonen, E., Ahtee, M. & Hannula, M.S. (2012). Third-graders' problem solving performance and teachers' actions. In T. Bergqvist (ed.): Proceedings of the ProMath meeting in Umeå, 69–81. University of Umeå.
- Mägi, K., Lerkkanen, M.-K., Poikkeus, A.-M., Rasku-Puttonen, H. & Kikas, E. (2010). Relations between achievement goal orientations and math achievement in primary grades: a follow-up study. *Scandinavian Journal of Educational Research*, 54(3), 295–312.
- Markus, H. & Kitayama, S. (1991). Culture and the self: implications for cognition, emotion and motivation. *Psychological Review*, 98(2), 224–253.
- Murphy, P. K., Delli, L. A. M. & Edwards, M. N. (2004). The good teacher and good teaching. Comparing the beliefs of second-grade students, preservice teachers, and inservice teachers. *The Journal of Experimental Education*, 72(2), 69–92.
- Op't Eynde, P., de Corte, E. & Verschaffel, L. (2002). Framing students' mathematics-related beliefs. In G. C. Leder, E. Pehkonen & G. Törner (Eds.), *Beliefs: a hidden variable in mathematics education?* (pp. 13–37). Dordrecht, The Netherlands: Kluwer.
- Pajares, F. & Miller, M. D. (1994). Role of self-efficacy and self-concept beliefs in mathematical problem solving: a path analysis. *Journal of Educational Psychology*, 86(2), 193–203.
- Partanen, A. M. (2011). *Challenging the school mathematics culture: an investigative small-group approach: ethnographic teacher research on social and sociomathematical norms*. Acta Universitatis Lapponiensis 206. Rovaniemi, Finland: University of Lapland, Department of Education.
- Polychroni, F., C. Hatzichristou, C. & Sideridis, G. (2011). The role of goal orientations and goal structures in explaining classroom social and affective characteristics. *Learning and Individual Differences*, 22(2), 207–217.
- Ramírez, M. (2005). Attitudes toward mathematics and academic performance among Chilean 8th graders. *Estudios Pedagógicos*, 31, 97–112.

- Sumpter, L. (2012). Themes and interplay of beliefs in mathematical reasoning. *International Journal of Science and Mathematics Education*, 11(5), 1115–1135.
- The Organisation for Economic Co-operation and Development (2010a). *PISA 2009 Results: What students know and can do – Student performance in reading, mathematics and science (Volume I)*. Retrieved from <http://www.oecd.org/pisa/pisaproducts/48852548.pdf>. Accessed 13 March 2015.
- The Organisation for Economic Co-operation and Development (2010b). *PISA 2009 Results: Overcoming social background—equity in learning opportunities and outcomes (volume II)*. Retrieved from <http://www.oecd.org/pisa/pisaproducts/48852584.pdf>
- The Organisation for Economic Co-operation and Development (2011). *Education at a Glance 2011: OECD indicators*. Retrieved from <http://www.oecd.org/education/skills-beyond-school/48631582.pdf>
- Tikkanen, P. (2008). “*Helpompaa ja hauskeempaa kuin luulin.*” *Matematiikka suomalaisten ja unkarilaisten perusopetuksen neljäluokkalaisten kokemana* [“Easier and more fun than I thought.” Mathematics experienced by fourth-graders in Finnish and Hungarian comprehensive schools]. *Jyväskylä Studies in Education, Psychology and Social Research* 337. Jyväskylä, Finland: Jyväskylä University Printing House.
- Tuohilampi, L. (2011). An examination of the connections between self discrepancies and effort, enjoyment and grades in mathematics. In M. Pytlak, T. Rowland & E. Swoboda (Eds.), *Proceedings of the Seventh Congress of the European Society for Research in Mathematics Education*, (pp. 1239–1248). Rzeszów, Poland: ERME.
- Tuohilampi, L., Laine, A., & Hannula, M. S. (2014a). 9-year old students’ self-related belief structures regarding mathematics: a comparison between Finland and Chile. In M. S. Hannula, P. Portaankorva-Koivisto, A. Laine & L. Näveri (eds.): *Proceedings of the 18th conference of the mathematical views*. Helsinki, Finland: MAVI
- Tuohilampi, L., Hannula, M. S., Varas, L., Giaconi, V., Laine, A., Näveri L. & Saló i Nevado, L. (2014b). Challenging western approach to cultural comparisons: young pupils’ affective structures regarding mathematics in Finland and Chile. *International Journal of Science and Mathematics Education*. doi:10.1007/s10763-014-9562-9.
- Valenzuela, J. P., Bellei, C. & Ríos, D. D. L. (2014). Socioeconomic school segregation in a market-oriented educational system. The case of Chile. *Journal of Education Policy*, 29(2), 217–241.
- Wagner, J. A., III & Moch, M. K. (1986). Individualism-collectivism: concept and measure. *Group and Organization studies*, 11(3), 280–304.
- Zhu, Y. & Leung, F. S. (2011). Motivation and achievement: is there an East Asian model? *International Journal of Science and Mathematics Education*, 9, 1189–1212.