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# Personal meaning and motivation when learning mathematics: A theoretical approach

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*Personal meaning, understood as the personal relevance of an object or an action (Vollstedt, 2011), seems to be closely related to motivation. However, the structural relationships between personal meaning and motivation are unexplored yet. Two motivation theories, self-determination theory (Deci & Ryan, 2002) and expectancy-value theory (Wigfield & Eccles, 2000), are used to work out these relations. The focus of this paper lies on theoretical considerations.*

*Keywords: Personal meaning, motivation, self-determination theory, expectancy-value theory, theoretical considerations.*

## Introduction

Students are in the need for meaning when dealing with mathematics in an educational context (Vinner, 2007). As Kilpatrick, Hoyles and Skovsmose (2005) point out, the notion of meaning is blurred in the mathematics education community:

When we consider the question of meaning with respect to mathematics education, the issue becomes even more complex, since philosophical and non-philosophical interpretations of meaning can become mixed. Thus, on the one hand, we may claim that an activity has meaning as part of the curriculum, while students might feel that the same activity is totally devoid of meaning. (Kilpatrick et al., 2005, p. 2)

This paper is interested in the perspective of the students and their individual attribution of personal relevance to deal with mathematics in an educational context. Vollstedt (2011) called this construct *personal meaning*. Theoretical considerations suggest a strong link between personal meaning and motivation drawing on the *basic needs theory (BNT)* and the *organismic integration theory (OIT)* of *self-determination theory (SDT)*, Deci & Ryan, 2002) and *expectancy-value theory (EVT)*, Wigfield & Eccles, 2000).

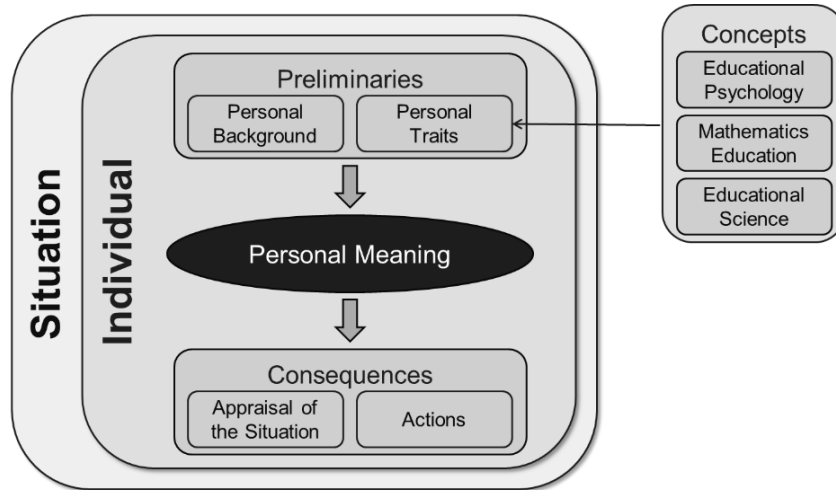
## Personal meaning

With respect to the fuzziness of meaning, Howson (2005) suggests that

one must distinguish between two different aspects of *meaning*, namely, those relating to relevance and personal significance (e.g., “What is the point of this for me?”) and those referring to the objective sense intended (i.e., signification and referents). These two aspects are distinct and must be treated as such. (Howson, 2005, p. 18)

According to Howson (2005), one important interpretation of meaning is the personal one. Personally experienced meaning, again, has a wide notion of concepts: it can be understood as a personal goal, a value, an intention, a purpose, a reference, or a use that an object or an action may have for the individual (Vollstedt, 2011).

Personally experienced meaning depends on the individual and a certain context (see below). It has an endogenous character, i.e. it cannot be provided by the teacher but, on the contrary, must be constructed out of the learner's individual biography (Meyer, 2008). Regarding mathematics, the need for meaning cannot be fulfilled globally: for each mathematical learning content, personal meaning must be constantly interpreted and subjectively constructed (Fischer & Malle, 1985). Therefore, at the same time and in the same context, different students can give different meanings to the same mathematical content (Kilpatrick et al., 2005; Vollstedt, 2011).



**Figure 1: Theoretical framework of personal meaning (Vollstedt, 2011)**

Vollstedt (2011) developed a model of personal meaning when learning mathematics and dealing with mathematical contents in a school context. In her theoretical framework (see Figure 1) she took the student's perspective, as the following two main preliminaries influence the construction of personal meaning: Firstly, the personal background of the student describes aspects which cannot be influenced by himself/herself like his/her socio-economic or migration background. Secondly, personal traits, i.e. aspects that concern the student's self, are relevant. They comprise concepts from various fields like educational psychology (self-concept, self-efficacy), education (developmental tasks), and mathematics education (beliefs). In addition to the individual preliminaries of a student, the situational context, i.e. context of the learning situation in terms of topic as well as classroom situation, is also a crucial factor for the construction of personal meaning. The theory of personal meaning developed by Vollstedt (2011) consists out of 17 different kinds of personal meaning. They were reconstructed based on interview data with students from lower secondary level from Germany and Hong Kong. These kinds vary between the duty to deal with mathematics because it is a school subject, the cognitive challenge that is contained in mathematical tasks, and the experience of relatedness among the fellow students. Note that the experience of the three basic psychological needs for *autonomy*, *competence*, and *relatedness* as described in the SDT of motivation (Deci & Ryan, 2002; cf. *Self-determination theory*) turned out to be meaningful for students. Accordingly, they were also given the status of kinds of personal meaning. The various kinds of personal meaning can be distinguished with regard to the intensity of the relatedness to mathematics and to the individual respectively, giving rise to seven superordinate types of personal meaning (see Figure 2).

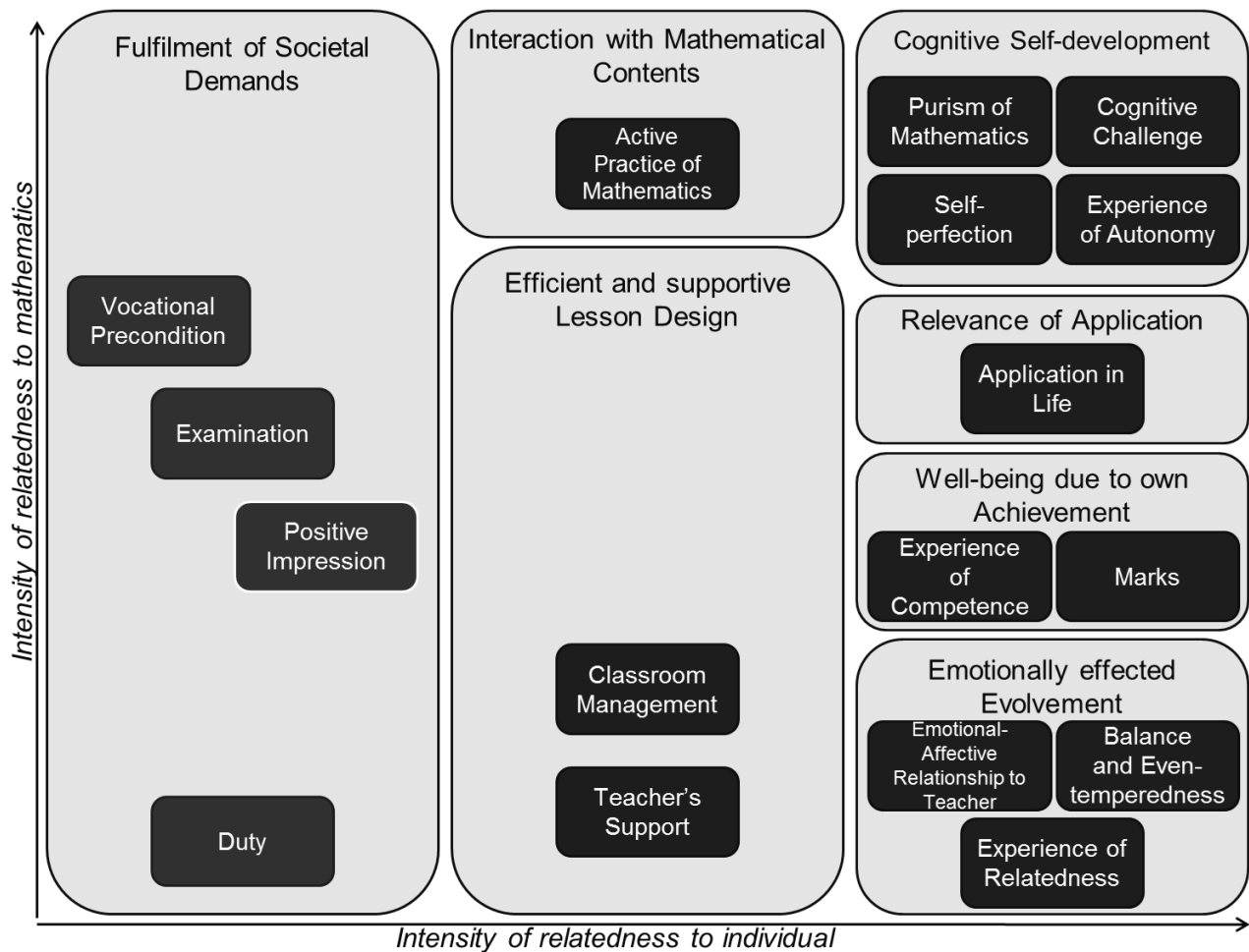


Figure 2: Model of personal meaning (Vollstedt, 2011)

A relation between the theories of personal meaning and motivation seems likely due to the obvious link via the SDT of motivation. Other links may additionally be assumed (see *Interplay between personal meaning and motivation* for further details). The structural connections between personal meaning and motivation, though, are yet unexplored.

## Motivation

### Self-determination theory

According to the SDT by Deci and Ryan (2002), learners have innate and constructive tendencies to develop an ever more elaborated coherent “sense of self” (Deci & Ryan, 2002, p. 5), i.e. individuals possess a tendency to promote growth or rather integration. They have the primary demand “to forge interconnections among aspects of their own psyches as well as with other individuals and groups in their social worlds”. This general integrative tendency is called the organismic metatheory of SDT. Besides, SDT includes the dialectical tendency, which focusses on the interaction between the active, integrating human nature and social contexts that either nurture or impede human’s effort to “integrate their experiences into a coherent sense of self” (Deci and Ryan, 2002, p. 27).

Those contextual elements can be defined by the basic psychological needs for competence, autonomy, and relatedness, which support or rather thwart motivation, performance, and well-being.

SDT embraces six sub-theories that all contain organismic and dialectic characteristics, two of which have a special significance for our study, namely the basic needs theory for competence, autonomy, and relatedness (BNT; Deci & Ryan, 2002, p. 22) and the organismic integration theory (OIT; Deci & Ryan, 2002, p. 14). These two sub-theories were formulated to clarify the interrelation between “motivation and goals to health and well-being” (Deci & Ryan, 2002, p. 10).

In BNT it is supposed that the basic needs are universal, i.e. they are valid across time, age, gender, situations, and culture. When they are satisfied, they support well-being, however when they are impeded, they might interfere with psychological health.

The OIT focusses on “internalization and integration of values and regulations (amotivated, external, introjected, identified, integrated, and intrinsic)” (Deci & Ryan, 2002, p. 14). Thereby, it defines the development and dynamics of extrinsic motivation in more detail. This process is characterized by “the degree to which individuals’ [sic] experience autonomy while engaging in extrinsically motivated behaviors” (Deci & Ryan, 2002, p. 9). This taxonomy of regulation is neither a developmental continuum by itself, nor do human beings have to proceed through each level of internalization. In fact, it is possible for humans to take in a regulation at any level, when the relevant prior experience and the immediate individual climate encourage the interpersonal basic needs.

### **Expectancy-value theory**

A second theory of motivation that stems from different theoretical roots is the EVT (Feather, 1982; Wigfield, Tonks, & Klauda, 2016). In it, motivation is described as a consequence of an interaction of *expectancy* and *value*. Wigfield and Eccles (2000) conceptualize motivation following EVT in a school context. They argue that “individuals’ choice, persistence, and performance can be explained by their beliefs about how well they will do on the activity and the extent to which they value the activity” (Wigfield & Eccles, 2000, p. 68). Expectancy address the perceived likeliness of achieving a set goal or being successful on a task (self-efficacy). Value represents the extent to which a goal or an activity is desirable (Eccles et al., 1983; Wigfield & Eccles, 1992).

Wigfield and Eccles (2000) describe four subjective task values: *attainment value*, *intrinsic value*, *utility value*, and *cost*. These are also referred to as the components of achievement value. Attainment value is described as the personal importance of doing well on a task, for example on a mathematical exercise. Intrinsic value is characterized by the sense of pleasure in doing that task. Utility value defines how a task suits one’s future plans or goals, such as making an effort during the mathematics lesson in order to be well prepared for an exam. Cost concerns how the decision of putting effort into an activity (e.g. doing mathematics homework) restrains opportunities for other activities (e.g. watching TV). The subjective task values serve the estimation of effort, the likelihood of task achievement, and emotional cost (Wigfield & Eccles, 2000).

## Interplay between personal meaning and motivation

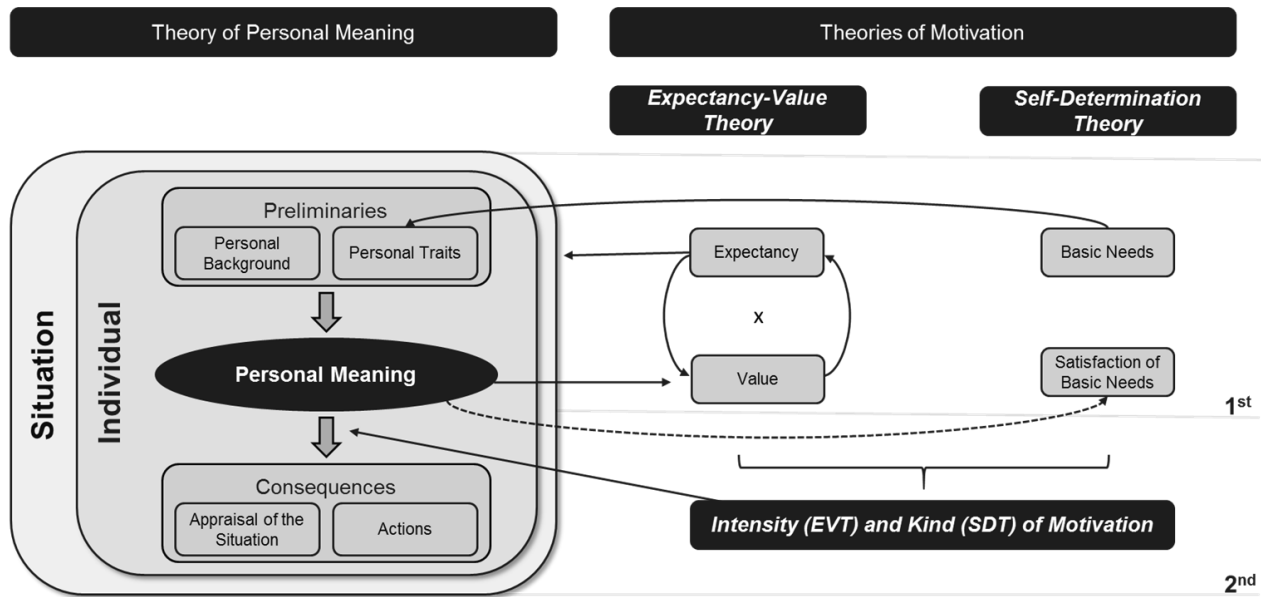
The conceptualizations of motivation introduced above contain various links to personal meaning. In a first approach, several networking strategies *comparing*, *combining*, *coordinating*, and *synthesizing* (Prediger & Bikner-Ahsbabs, 2014) were used to connect the different theoretical perspectives and construct an elaborated theoretical framework of the interrelation between personal meaning and motivation. This process is described below.

Common similarities and differences between parts of theoretical approaches can be identified through the networking strategy of comparing (Prediger & Bikner-Ahsbabs, 2014). Comparing the three theoretical approaches shows that in general, the theories of personal meaning, SDT, and EVT all include organismic and dialectical components, i.e. they consider the learner's biography in detail and the constant interaction with the learner's social environment (Bruner, 1991; Deci & Ryan, 2002; Vollstedt, 2011; Wigfield & Eccles, 2000). This is an essential factor and forms the basis for further elaboration of the concrete interaction between these three theories.

The networking strategy of combining makes it then possible to combine theoretical approaches even from different origin. As EVT-values and intrinsic and extrinsic constructs of SDT are examined from different theoretical perspectives they, thus, have different bases (Wigfield & Eccles, 2000; Wigfield, Tonks, & Klauda, 2016). Nevertheless, close relations could be extracted by combining the theoretical constructs of SDT and EVT: The intrinsic value of EVT is linked to the construct of intrinsic motivation as described in SDT. It refers to behaviors performed out of one's own interest, enjoyment, and the pleasure inherent in these activities (Ryan & Deci, 2002). Utility value describes more extrinsic motives to put effort in a mathematical task, such as doing a task to attain certain outcomes. Accordingly, utility value can be connected to extrinsic motivation (Wigfield & Eccles, 2000). Hence, extrinsic rewards may also help to anticipate individuals' own efforts (Spence & Helmreich, 1983). In addition, SDT points out that the regulation of motivation is important to pursue a certain goal or value. Thus, it differentiates between qualitatively different reasons for action, arguing that different types of motivation will lead to very different outcomes (Ryan & Connell, 1989).

Through the networking strategy of coordinating it is possible to clarify empirical evidence by constructing a conceptual framework grounded in different theoretical ideas. Hence, the three theories were interwoven and synthesized to link equally solid theories in such a way that a new unit of theory arises into, for example, an elaborated new theoretical approach (see Figure 3 below). To begin with, personal meaning and SDT are linked in three ways (cf. also the section *Personal meaning* above): Firstly, the three basic psychological needs for competence, autonomy, and relatedness as described in BNT are part of Vollstedt's (2011) theoretical background for the construction of personal meaning (see Figure 3 below). Secondly, their experience turned out to be meaningful for students so that there are three kinds of personal meaning closely related to the three basic psychological needs (see Figure 2 above). Thus, these two aspects directly link the theory of personal meaning to SDT. Thirdly, there is an indirect link. One of the two overall-dimensions of the model of personal meaning, namely the intensity of the relatedness to the individual, describes the degree of one's subjective involvement in the action or the content respectively. Vollstedt's results (2011) suggest that the intensity of the relatedness to the individual is possibly interrelated with the types of regulation described in OIT. This results from the fact that the intensity of the relatedness to the individual focuses on the personal involvement of the individual with respect

to the action or object in focus. Hence, this establishes a link to self-determined behavior and internalization (Vollstedt, 2011).



**Figure 3: The role of personal meaning in the generation of motivation according to EVT**

With relation to EVT, we also suppose a close link to the theory of personal meaning (see Figure 3 above). We assume that the expectancy as described in EVT is part of the individual's personal traits, i.e. they are contained in the crucial preliminaries for the construction of personal meaning (cf. the section *Personal meaning*). Besides, the subjective values of EVT are embodied in different kinds of personal meaning (cf. the section *Expectancy-value theory*). For instance, the particular nature of intrinsic value is inherent in those kinds of personal meaning which refer mostly to the relatedness to mathematics or the learning of mathematics (e.g. "Purism of mathematics", see Figure 2 above). Another assumption that can be made refers to the relation between utility value and the kinds of personal meaning which have instrumental or functional character (e.g. "Vocational Precondition"). Furthermore, attainment value may relate to those kinds of personal meaning which refer to the knowledge of mathematics being important for one's own identity (e.g. "Self-perfection").

These considerations suggest that motivation may be understood as a result from the interaction between expectancy being characterized by the preliminaries of an individual, and the values being embodied by the different kinds of personal meaning. The resulting motivation influences the consequence that results from the construction of personal meaning. Thus, depending on the kind of personal meaning and its related motivation, an action will follow that may but does not have to do with mathematics (e.g. doing homework instead of playing football – or vice versa). Hence, the inclusion of EVT may provide additional insight into the interplay between personal meaning and motivation.

When looking at the interplay of personal meaning and motivation as a process, with reference to EVT we suggest to think of personal meaning as being constructed chronologically before motivation.

In our understanding, personal meaning is the energizing factor (1<sup>st</sup> in Figure 3 above), which is significant for the students' motivation (2<sup>nd</sup> in Figure 3 above). We even assume that personal meaning is necessarily required for motivation, i.e. that the individual must think that something is

meaningful for him/her and, thus, is motivated to engage in an action that supports his/her goals and values. This suggestion gives personal meaning the status of a key factor for the theory of motivation in general (see Figure 3).

## Conclusion and further perspectives

This paper provides the theoretical background to examine the relationship between personal meaning and motivation when learning mathematics. Hence, personal meaning is linked with motivation through the two motivation theories of SDT and EVT. The results of Vollstedt's (2011) study may suppose connections between personal meaning and SDT, i.e. BNT and OIT (Deci & Ryan, 2002). Three of the subjective values of EVT (attainment value, intrinsic value, and utility value) may be embodied by certain kinds of personal meaning. As cost has a negative connotation, it is not related to personal meaning denominating personal relevance of an object or action.

To conclude, we assume an interrelation between personal meaning and motivation as has been elaborated above. The model sketched above will be elaborated further in an empirical study.

## References

- Bruner, J. (1991). *Acts of meaning*. Cambridge, Staat: Harvard University Press.
- Deci, E. L., & Ryan, R. M. (2002). *Handbook of self-determination research*. Rochester, New York, NY: University of Rochester Press.
- Eccles, J. S., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J. L., & Midgley, C. (1983). Expectancies, values, and academic behaviors. In J. T. Spence (Eds.), *Achievement and achievement motivation* (pp. 75–146). San Francisco, CA: W. H. Freeman.
- Fischer, R., & Malle, G. (1985). Lokale, bedingte Sinn-Argumentation. In R. Fischer, & G. Malle (Eds.), *Mensch und Mathematik: Eine Einführung in didaktisches Denken und Handeln* (pp. 9–26). Mannheim: BI Wissenschaftsverlag.
- Feather, N.T. (1982). Introduction and overview. In N.T. Feather (Eds.), *Expectations and actions. Expectancy-value models in psychology* (pp. 1–14). New Jersey, NJ: Lawrence Erlbaum.
- Howson, G. (2005). “Meaning” and school mathematics. In J. Kilpatrick, C. Hoyles, & O. Skovsmose. (Eds.), *Meaning in mathematics education* (pp. 17–38). New York, NY: Springer.
- Kilpatrick, J., Hoyles, C., & Skovsmose, O. (2005). Introduction. In J. Kilpatrick, C. Hoyles, & O. Skovsmose. (Eds.), *Meaning in mathematics education* (pp. 1–8). New York, NY: Springer.
- Meyer, M. A. (2008). Unterrichtsplanung aus der Perspektive der Bildungsgangforschung. In M. A. Meyer, M. Prenzel, & S. Hellekamps (Eds.), *Perspektiven der Didaktik: Zeitschrift für Erziehungswissenschaft. Sonderheft 9* (pp. 117–137). Wiesbaden: VS Verlag für Sozialwissenschaften.
- Prediger, S., & Bikner-Ahsbahs, A. (2014). Introduction to networking: Networking strategies and their background. In A. Bikner-Ahsbahs & S. Prediger (Eds.), *Networking of theories as a research practice in mathematics education* (pp. 117–125). Switzerland: Springer International Publishing.
- Ryan, R.M., & Connell, J.P. (1989). Perceived locus of causality and internalization: Examining reasons for acting in two domains. *Journal of Personality and Social Psychology*, 57, (749–761).



- Ryan, R. M., & Deci, E. L. (2002). An overview of self-determination theory: An organismic-dialectical perspective. In E. L. Deci & R. M. Ryan (Eds.), *Handbook of self-determination research* (pp. 3–33). Rochester, New York, NY: University of Rochester Press.
- Spence, J.T., & Helmreich, R.L. (1983). Achievement-related motives and behaviors. In J. T. Spence (Eds.), *Achievement and achievement motivation* (pp. 7–73). San Francisco, CA: W. H. Freeman.
- Vinner, S. (2007). Mathematics education: Procedures, rituals and man's search of meaning. *Journal of Mathematical Behavior*, 26, 1–10.
- Vollstedt, M. (2011). *Sinnkonstruktion und Mathematiklernen in Deutschland und Hongkong. Eine rekonstruktiv-empirische Studie*. Wiesbaden, Germany: Vieweg+Teubner.
- Wigfield, A., & Eccles, J.S. (1992). The development of achievement task values: A theoretical analysis. *Development Review*, 12, 265–310.
- Wigfield, A., & Eccles, J.S. (2000). Expectancy-value theory of achievement motivation. *Contemporary Educational Psychology*, 25, 68–81.
- Wigfield, A., Tonks, S., & Klauda, S. L. (2016). Expectancy-value theory. In K. R. Wentzel & A. Wigfield (Eds.), *Handbook of motivation at school* (pp. 55-75). New York, NY: Routledge.