# Theoretical background

Gliederung nach Fragestellungen:

1. Stress / Arousal im Lehrberuf:
   1. Lehrberuf besonders anspruchsvoll, gefährdete Berufsgruppe
   2. Was ist Stress / Arousal (cognitive appraisal)
   3. und wie ist es messbar?
   4. HR ist ein wichtiger Indikator 🡪 Baseline HR (um z-std. HR einzuführen)
2. Am Handgelenk getragene Fitnesstracker als neue Messmethode der HR
   1. Bisheriger Forschungsstand allgemein und speziell im Bildungs-/Schulkontext
   2. HR-Unterschiede in unterschiedlichen Lehrphasen
3. Prädiktion der HR mittels Lehrerfahrung & self-reported data
   1. Ähnliche Konstrukte wie c.a. 🡪 self-efficacy + HR during teaching (Richter e al.)
   2. was hat Berufserfahrung und cognitive appraisal damit zu tun?

## Stress in teaching profession

Facing a variety of stressors during the everyday work, the teaching profession is one of the most stressful professions compared to other occupational groups [@smith2000; @herman2020]. Teacher stress can be defined as “a response of negative affect (such as anger or depression) by a teacher usually accompanied by potentially pathogenic physiological and biochemical changes (such as increased heart rate […]) resulting from aspects of the teacher's job and mediated by the perception that the demands made upon the teacher constitute a threat to his self-esteem or well-being and by coping mechanisms activated to reduce the perceived threat.” [@kyriacou1978, p. 2]. This definition of teacher stress can be systematized under the integrative framework of the transactional stress model [@lazarus1987; @obbarius2021]. The model highlights the interaction between an individual and its environment. It proposes that personal cognitive appraisal processes have a significant impact on a stress reaction. It is critical to distinguish between two types of cognitive appraisal: When faced with stressors, a person assesses both the stressors' relevance (primary appraisal) and its own capacity for overcoming stress (secondary appraisal). How teachers evaluate the demands depends on the interaction between their individual characteristics and their perception of the demands placed on them. Teachers’ individual characteristics such as biographical details (e.g., sex, age, teaching experience) may be of high importance of the appraisal. Primary and secondary appraisals are regarded to have an impact on a person's coping mechanisms. The immediate stress reaction, long-term health, psychological well-being, and social functioning are in turn all impacted by coping strategies [@obbarius2021].

Stress as a biopsychosocial phenomenon includes in addition to motivational and cognitive components physiological aspects [@blascovich1999]. Thus, the response of negative affect can be a psychological (e.g., job dissatisfaction), physiological (e.g., increased HR), and behavioral (e.g., absenteeism) stress reaction [huang2022class; @van2001stress]. Psychosomatic stress symptoms such as an increasing HR result from an interaction of situational stressors and person-specific available resources [@rotter2020]. Stressors are considered as antecedents of teacher stress and can be classified as physical (e.g., class size), psychological causes (e.g., student misbehavior) or a combination of both physical and psychological (e.g., high workload) [@chen1997teacher].

## Classroom disruptions as a stressor

Student misbehaviors such as classroom disruptions, disrespect and disciplinary problems are one of the most influential stressors [@aloe2014multivariate]. In contrast to disciplinary conflicts and disrespect, classroom disruptions are linked to the teaching process and can be defined as “events that impair, interrupt or make the teaching-learning process impossible by partially or completely overriding the conditions under which teaching and learning can take place” [@lohmann2007schulern, p. 13]. Classroom disruptions can be differentiated according to various aspects (e.g., intensity and severity (Steins & Welling, 2010); active and passive disruptions (Nolting, 2017). @lohmann2007schulern distinguished four categories: verbal disruptive behavior (e.g., chatting, heckling), lack of eagerness to learn (e.g., looking at the phone, putting the head on the table), physical disruptive (e.g., clicking with a pen, drumming with the hands on the table), and aggressive behavior (e.g., attacking or insulting classmates) [@lohmann2007schulern; based on Mayr, 1987).

* Individuelles Störempfinden

The relevance of the issue is obvious: If teachers are exposed to a stressful or disruptive teaching-learning environment over a long period and do not have sufficient resources and coping strategies, it can lead to negative personal and vocational consequences such as burnout, high turnover and premature retirement [@jalongo2006; @unterbrink2007; @aloe2014]. Teacher stress is therefore an important aspect in the way teachers behave and react in the classroom.

## HR as an indicator for stress

According to the biopsychosocial model, an increased HR is an indicator of a situation that is judged by an individual to be goal-relevant and that requires attention as well as overt or cognitive action which can be evaluated by the person and observers (motivated performance situations; @blascovich1996).

The HR is physiologically regulated and influenced on short-time intervals by the autonomic nervous system which is subdivided into two distinct components: the sympathetic and the parasympathetic nervous system [@pham2021]. An increase in the activity of the sympathetic, known as the “quick response” system, results in the HR being speeded up ("fight or flight").[[1]](#footnote-1) On the other hand, an increased activity of the parasympathetic as the counterpart and known as the “relaxed response” system, has the effect of slowing down the HR ("rest and digest") [@battipaglia2015].

In addition to the autonomic nervous system and genetic factors, HR is influenced by numerous external factors such as social, personal, psychological, environmental and behavioral factors [@wang2022].

Exercise-induced excitation of the sympathetic nervous system results in activation of the cardiovascular system, which is why an increasing HR can be regarded as an indicator of increasing stress on the cardiovascular system [@junker2021; @kyriacou1978].

choose cardiovascular measures such as HR or blood pressure changes (i.e. reactivity) to index the arousal associated with stress - the higher the HR or blood pressure, the more stressed the individual. [@blascovich1996, 4)

HR differences in different intervals; siehe Gagnon, Junker, Kärner, 10min intervall Paper

## Assessing Teacher Stress

In stress research relating to the teaching profession, there is a particular interest in finding adequate indicators and quantitatively measurable parameters for teacher stress and burnout [@fisher2011; @ junker2021; @runge2020]. Previous research on teacher stress often focused on psychological experience of stress using self-report questionnaires with single item measures (“I find teaching to be very stressful‖”) [@chaplain2008; @goker2012] or questionnaires with multiple scales (e. g. Teacher Stress Inventory; @fimian1990; @liu2020].

@fisher2011 for example investigated the extent to which age or teaching experience and job dissatisfaction are associated with an increased risk of burnout and stress among teachers. The results showed that stress had no significant correlation with age or teaching experience, although it was found that teachers with less professional experience had a higher burnout score. @fisher2011 concluded that years of professional experience, burnout and satisfaction in the teaching profession are statistically significant predictors of teacher stress.

There are only a few studies that investigated physiological indicators such as HR as an indicator of teacher stress during teaching [@sperka1995; @scheuch1997psychophysische; @donker2018; @junker2021; @runge2020; @huang2022class].

@sperka1995 for example recorded the HR of 16 pre-service teachers during their first lesson. As expected, the results show that the first lesson is linked to significantly increased psychophysiological activation in terms of an increased HR, whereas the activation effect was particularly prominent at the beginning of the lesson and decreased in the course of the lesson due to the pre-service teachers’ active coping process (active management of the interaction with the students).

@scheuch1997psychophysische assessed the HR of 67 teachers during five real lessons, with results showing that the highest HR occurred during organizational activities, followed by teaching activities where the teacher directed the interaction.

@donker2018 investigated 80 teachers’ HR as a proxy for their affective response during a regular classroom lesson and coded their interpersonal behavior during teaching. The results indicated that teachers showed an increased HR when they had a leading role in student-teacher-interactions.

@junker2021 recorded the HR of 40 teachers during a real classroom lesson using an electrocardiogram to find out to what extent main stressors within the classroom (e.g., low student engagement and motivation, teacher-centered activities), can predict teachers’ HR as an indicator of physiological stress during teaching.[[2]](#footnote-2) @junker2021 were able to prove that teacher stress caused by stressors during teaching can be quantitatively measured by an increase in HR. In particular, teacher-related activities and a lack of engagement and motivation of students were characterized by an increase in teachers’ HR.

In the study by @runge2020, HR was one of several parameters used to identify stress in teachers based on physical characteristics using a Fitbit fitness tracker. Another aim was to find out to what extent affordable fitness trackers and the provided parameters can be used to measure teacher stress. @runge2020 concluded that stress in the teaching profession can be mapped using the indicators that fitness trackers measure. In particular, it was found that the combination of a high number of steps, a high HR and short sleep is an indicator of stress and that poor student behavior is the stressor that is perceived most frequently.[[3]](#footnote-3)

@huang2022class conducted a randomized, controlled experiment with 65 pre-service teachers. In a standardized virtual reality classroom, they investigated whether class size has a direct effect on physiological (HR) or psychological (subjective evaluation) stress reactions which could be confirmed for both stress reactions.

## Wrist-worn devices as a new approach to assess physiological stress reactions

In all but one of the studies listed [@runge2020], the HR was recorded using very expensive and invasive electrocardiographs (ECG devices), which contributes to accurate measurements.

However, since the 1970s, increasing efforts have been made to realize precise measurements of HR in mobile form, as it was only possible with the ECG at that time (Hottenrott, 2007). These efforts were driven in particular by competitive sport, resulting in the first portable HR measuring devices in the form of chest straps and wristbands being used only in this field. In the meantime, HR measurements and the associated monitoring of individual stress levels have become established both in the fitness sector and in competitive sport.

This development has led to commercial wearable fitness tracker becoming increasingly popular among the wider population in the last decade to record physical activity in everyday life [@gagnon2022; @feehan2018accuracy; @fuller2020; @jo2016; @hajj2023]. Furthermore, they are also increasingly being used in the context of health-promoting research [@feehan2018accuracy]. This can be explained by the low costs compared to complex laboratory methods for determining vital parameters such as HR, blood pressure, skin temperature, and physical activity, the portable, non-invasive nature and the ease of use [@hajj2023].

In teaching-learning contexts, physiological measurements such as HR provide researchers with an objective insight into teachers’ affectivity without interrupting the teaching process [@donker2018]. Thus, it is important to monitor HR accurately since this marker may be used to identify an individual’s level of experienced stress during an activity. As a result, there are a large number of scientific publications that deal with the validity and reliability of the parameters measured by fitness tracker [gagnon2022; @fuller2020; @jo2016; @hajj2023].

Research on the reliability of wrist-worn devices for the measurement of HR showed that Fitbit watches are accurate in controlled settings [hajj2023; @fuller2020]. However, some studies indicate that fitbit watches do not meet validity criteria and show a significant decrease in accuracy, especially at higher exercise intensities [@jachymek2021; @jo2016]. @gagnon2022 concludes in his study, that Fitbit devices can be used in research to detect stress-induced HR variation, but they cannot replace an ECG machine when precision is of greatest importance.

1. During short-term or acute psychological stress, the hypothalamic-pituitary-adrenal axis is activated (HPA; Hellhammer et al., 2009). The production of glucocorticoids by the adrenal glands then stimulates the cardiovascular tissue and provides feedback to the central nervous system to prevent activation of the HPA axis. Stimulation of the cardiovascular tissue during stress causes an increased HR (Burford et al., 2017). [↑](#footnote-ref-1)
2. As part of the evaluation, interest focused on periods in which the HR was at least two standard deviations above the average HR of the participants. [↑](#footnote-ref-2)
3. It should be noted that the generalizability of the results is limited due to the small sample size of four participants. [↑](#footnote-ref-3)