# EMBODIED COGNITION IN PREVENTION OF MUSICIAN'S MUSCULOSKELETAL PROBLEMS IN LEARNING ENVIRONMENT:
## AN INTEGRATIVE REVIEW

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Master's thesis
Music science
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Spring 2024

# UNIVERSITY OF JYVÄSKYLÄ

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| Tiedekunta – Faculty<br>Humanities | Laitos – Department<br>Music Department |
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| Työn nimi – Title<br>Embodied Cognition in Prevention of Musician's Musculoskeletal Problems in Learning Environment:<br>An Integrative Review | |
| Oppiaine – Subject<br>Music Science | Työn Laji – Level<br>Master's Thesis |
| Aika – Month and year<br>July 2024 | Sivumäärä – Number of pages<br>112 |


Tiivistelmä – Abstract

My assumption is that the low focus on issues according to motor skills development, multisensory development and playing-related ergonomics contributes to the prevalence of musculoskeletal symptoms among professional musicians. This thesis is conducted as an integrative review by synthesizing the current research of embodied cognition and the prevention of musician's musculoskeletal problems and its applied possibilities for learning environment identifying the preventive, wellbeing promoting and embodied role of musical practice.

The thesis is conducted as a mixed method integrative literature review with inductive research design analysed and synthesized with thematic, constant comparative and content analysis as the critical interpretive approach and narrative summary suitable for mixed method research synthesis. The data search was conducted 11.10.2023. 11 studies were included for qualitative synthesis of which 8 were research articles and 3 were dissertations. Included studies emphasized teaching methods, holistic prevention and embodied cognition in musical learning environment.

The synthesis developed around two high-level themes: 1) Embodiment and Embodied Self-Regulation and 2) Environment in Cognitive Strategies. Based on synthesis, research program of embodied cognition could bring added value to the development of prevention of musician's musculoskeletal problems regarding the sensory and attentional control-focused perspectives of somatic methods in the learning environment by considering embodied and environmental cues, embodied music cognition, ontological questions related to embodiment and several environment-related practical aspects.



**Avainsanat – Keywords** embodied cognition, music pedagogy, prevention, musculoskeletal problems, PRMD

Säilytyspaikka – Depository University of Jyväskylä

Muita tietoja – Additional information

# JYVÄSKYLÄN YLIOPISTO

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Tiivistelmä – Abstract

Oletukseni mukaan vähäinen keskittyminen motoristen taitojen kehitysvaiheisiin, moniaistiseen kehitykseen sekä soittimen opetteluun liittyvään ergonomiaan lisää tuki- ja liikuntaelimistön oireiden esiintyvyyttä ammattimuusikoiden keskuudessa. Tämä opinnäytetyö on tehty integroivana katsauksena syntetisoimalla uuden sukupolven kognitiotiedettä ja muusikoiden tuki- ja liikuntaelimistön ongelmien ennaltaehkäisyn tutkimusta sekä sen soveltamia mahdollisuuksia oppimisympäristöön tunnistaen musiikillisen harjoituksen ennaltaehkäisevän, hyvinvointia edistävän sekä keholliskognitiivisen roolin.

Opinnäytetyö tehtiin integroivana kirjallisuuskatsauksena, joka analysoitiin ja syntetisoitiin induktiivista tutkimussuunnitelmaa hyödyntäen temaattisen, vertailevan sekä sisältöanalyysimenetelmien avulla käyttäen kriittistä tulkintaa ja kerronnallista yhteenvetoa, jotka soveltuvat sekamenetelmä- tutkimuksen synteesiin. Tiedonhaku suoritettiin 11.10.2023. Sisällytin 11 tutkimusta kvalitatiiviseen synteesiin, joista 8 oli tutkimusartikkeleita ja 3 väitöskirjoja. Mukana olevat tutkimukset painottivat soitonopetusmenetelmiä, kokonaisvaltaista ennaltaehkäisyä sekä uuden sukupolven kognitiotiedettä musiikillisessa oppimisympäristössä.

Synteesi kehittyi kahden korkean tason teeman ympärille: 1) kehollisuus ja keholliskognitiivinen itsesäätely ja 2) ympäristö kognitiivisissa strategioissa. Synteesin perusteella uuden sukupolven kognitiotieteen tutkimusohjelma voisi tuoda lisäarvoa muusikoiden tuki- ja liikuntaelimistön ongelmien ennaltaehkäisyn kehitykseen huomioiden somaattisten menetelmien aisti- ja huomionhallintakeskeisiä näkökulmia sekä kehollisia ja ympäristöön liittyviä vihjeitä oppimisympäristössä, kehollisen musiikkikognition näkökulmia, kehollisuuteen liittyviä ontologisia kysymyksiä sekä useita ympäristön hyödyntämiseen liittyviä opetuskäytännön näkökohtia.



**Avainsanat – Keywords** embodied cognition, music pedagogy, prevention, musculoskeletal problems, PRMD

Säilytyspaikka – Depository University of Jyväskylä

Muita tietoja – Additional information

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# 1 INTRODUCTION

"The prevalence of musculoskeletal symptoms is high among professional musicians (73–88%) … Symphony orchestra musicians experience nearly twice as much musculoskeletal symptoms of the neck and upper extremities as others their age" (Viljamaa, Liira, Kaakkola & Savolainen, 2017). My assumption is that the low focus on developmental stages of motor skills, multisensory development, and issues according to the playing-related problems in learning environments contributes to the results of the above study. With the development of medicine and physiotherapy focusing on treatment and rehabilitation of the musician's musculoskeletal problems, a gap in the literature related to the prevention is to be found. According to the Kokko and colleagues' study (2019), the range of importance of physical activity (PA) has narrowed and just over a third of Finnish children and young people exercised according to the recommendations. (Kokko et al., 2019) The above study is the component in the core of the problem. "Governmental support for PA promotion among school-aged children and youth in Finland during past few years has been stronger than ever before. Nevertheless, the proportion of Finnish children and youth who achieve the recommended levels of daily PA and screen time is still low. Facilitating a population level change in PA among children and youth requires wide collaboration and contribution of different sectors and actors." (Kämppi et al., 2018). The negative development in the general lack of exercise will likely increase the prevalence of musculoskeletal problems among musicians and worsen an already existing problem. The recent theory of embodied cognition recognizes human cognition being actively integrated to sensory and motor systems (Leman, Maes, Nijs and Van Dyck, 2018). By my assumption embodied cognition could enable understanding of the cause-and-effect relationships of musculoskeletal problems considering cognitive, sensorimotor, and environmental factors related to the meaning of the movement and growth, in which case they can be considered in the planning of preventive musical practice and diversifying the societal meaning of movement.

## 1.1 Research Design

The thesis has an inductive study design and is informed by the theory of embodied cognition. The thesis is conducted as a mixed method integrative literature review design analyzed and synthesized with thematic, constant comparative and content analysis as the critical interpretive approach and narrative summary suitable for mixed method research synthesis (MMRS). (Toronto and Remington, 2020; Haevert, Hannes, Onghera, 2017). The thesis is structured under the five main sections. The first section consists of the methodological (1.1) and the conceptual (1.2) frameworks. Methodological framework consists of the description of the methods used and the relevant philosophical and theoretical basis for the work. Conceptual framework includes the preliminary review to survey the research problems and questions, background factors and the gaps in the literature. The second section presents the search strategy and analysis including the processing stages (2.1) of data screening, selecting and extraction and explanation of the analysis process and the analysis methods used (2.2). The section three (3.1, 3.2) synthesizes findings from the data extraction stage with the purpose to create theoretical and practical tools for developing preventive pedagogical practices and understand the preventive and embodied value of the music for a society. The fourth section includes conclusion reviewing the issues, limitations (4.1) and implications (4.2) raised from the thesis. The fifth section presents the major findings. An integrative review is a suitable method for the thesis because the topic includes recent, fragmented, and multidisciplinary information. Bringing the fragmented information together can serve as a basis for practical application.

An integrative review is a part of the systematic reviews and synthesizes empirical and non-empirical information and usually has broadly defined purpose sometimes including interdisciplinary approaches. It can also be part of the integrated mixed-method research. A large proportion of integrative reviews do not contain theoretical and conceptual framework to guide the structure and analysis and in many cases the framework is based on the results (Toronto and Remington, 2020). Toronto and Remington (2020) states that "IRs provide synthesis on: (1) empirical research (review of quantitative and/or qualitative empirical studies on a particular topic), (2) methodological (review and analyses of designs and methodologies of different studies), and (3) theoretical (review of theories on a particular topic) (Whittemore et al. 2014; Soares et al. 2014) … The IR method enables a reviewer to address: (1) the current state of evidence of a particular phenomenon, (2) the quality of the evidence, (3) gaps in the literature, and (4) identify the future steps for research and practice (Russell 2005).

(Toronto and Remington, 2020). Whittemore and Knafl (2005) states an integrative literature review being the only scientific approach allowing combination of experimental and nonexperimental research. It also allows using theoretical and empirical literature. Integrative research provides a basis and ideas for practical development and application of knowledge. Integrative reviews include a wide range of purposes, such as defining concepts, reviewing theories, reviewing evidence, and examining methodological issues (Whittemore and Knafl, 2005).

The second section (2) describes narratively processes of the search and analysis. The sections of the search strategy (2.1, 2.1.1, 2.1.2, 2.1,3) describe the processes and tools for screening all the literature and analysis process by using figures and tables. The objective is to decide about the texts to be included for the full-text retrieval. Initial screening entails screening titles and abstracts of potentially relevant literature using identified criteria. Then, the full text of the remaining literature is evaluated to determine the inclusion. The reviewer will next document this process and the reasons why an article was excluded in a search flow diagram." (Toronto and Remington, 2020). The second section's search strategy includes an condensed description of the process according to eligibility criteria, screening and selecting of the searched data and critical appraisal of the included data as well as the analysis tools. The stage includes a discussion and evaluation of the eligibility criteria (2.1.1) that will be justified. The eligibility criteria open and justify the inclusion and exclusion criteria for the searched data. The inclusion and exclusion criteria should identify whether inferior studies will be included or excluded after the appraisal process. According to Toronto and Remington (2020) "Some suggest that all studies should be considered in the review, despite low-quality ratings to allow for more diversity among the sample, whereas others suggest that synthesizing studies of high quality with those of lesser quality may lead to inaccurate conclusions" (Toronto and Remington, 2020). Screening and selecting (2.1.2) describes the inclusion process with the flow diagram of the data. Inclusion and exclusion criteria are necessary that the amount of the literature is more manageable and required literature is easier to identify. Examples of inclusion criteria are the phenomenon, characteristics of the population being studied, language of the publications, time etc. (Toronto and Remington, 2020).

The stage of critical appraisal (2.1.3) is for assessing the value and reliability of the included literature and has justified statements for decisions. Many appraisal tools are checklist with response format. For the better quality in future research the numerical or qualitative ratings of the appraisal could be included in tables and matrices for comparing the quality of findings. More than 100 appraisal tools have been identified to appraise methodological quality of primary research. (2020). Examples of

commonly used critical appraisal tools are Critical Appraisal Skills Program (CASP), Joanna Briggs Institute (JBI), Johns Hopkins research evidence appraisal tool and Rapid critical appraisal checklists. Results of the appraisal are documented in the matrixes. Theoretical literature has own critical appraisal tools." The author of a theoretical article presents a new theory, analyses an existing theory, or elaborates a theoretical position. These articles do not contain existing empirical information unless it advances the theoretical issue (American Psychological Association 2010)." (Toronto and Remington, 2020). The stage of data extraction (2.2) describes the analysis methods and tools used narratively and, in the tables, as well as how the analysis was performed using different methods by ordering, coding, and categorizing data from multiple sources. To assist with coding and analysis, coding can be done manually or by using tools like NVivo or similar tools. Abstracting process takes place by tabulation, which reveals how the phenomenon has developed and what is known or unknown (Toronto and Remington, 2020). "The descriptive data extraction process consists of four steps: (1) deciding which data will be extracted and developing a preliminary data extraction form and coding guide, (2) piloting the extraction form and the coding guide, (3) conducting the data extraction, and (4) identifying and discussing differences in extraction between review authors." (Haevaert, 2017).

Thematic analysis is common in integrative reviews and qualitative research. It helps to identify and organize the most important and recurring themes and concepts. The themes are formed based on research questions. Toronto and Remington (2020) present the six-phase process for thematic analysis that include familiarizing yourself with your data, generating initial codes, searching for themes, reviewing themes, defining, and naming themes, and producing the report. The steps include coding the initial data to generate initial codes to identify the interesting information. Then the codes are made into themes and subthemes with the help of visual representations like tables, mind maps and theme piles. After that, some themes will be condensed and expanded, and a candidate map (s) will be created. Candidate themes define what the story and information content of the themes are. The final themes should give an idea of the subject. Finally, a narrative report is made across themes and sufficient evidence is provided to support the themes. Constant analysis synthesizes the literature and consist of data reduction, data display, data comparison, conclusion drawing and verification. Data reduction includes the search for different subcategories to match the research questions and the data display compress the data into matrices. According to Toronto and Remington, assembling the different matrices to align with the subcategories may be necessary during data reduction to help the to see the relationships and patterns emerging from the data. The data comparison stage searches

patterns, themes, commonalities, differences, and relationships including clustering, counting, making contrasts and comparisons. (Toronto and Remington, 2020.)

According to Toronto and Remington (2020) the discourse of an integrative review emerged in the 1980s in the fields of education, psychology, and nursing and has developed slowly due to the need to combine different methodologies. Combining different methodologies can challenge the making of conclusions and syntheses, but it has become popular precisely because of the use of versatile data sources and through the opportunity to answer the narrow questions that appear in systematic reviews more broadly. (Toronto and Remington, 2020) Inductive analysis approach involves interpreting data to develop themes, concepts, or model for interpreting the data and reaches general conclusions from a specific problem. Strategically, the thesis progresses from the whole to the details and back, i.e., it follows the so-called hourglass model. (Toronto and Remington, 2020). Creswell and Clark (2011) describe "Mixed methods research originated in the social sciences and has recently expanded into the health and medical sciences including fields such as nursing, family medicine, social work, mental health, pharmacy, allied health, and others. In the last decade, its procedures have been developed and refined to suit a wide variety of research questions". (Creswell and Plano Clark, 2011). These procedures include advancing rigor, offering alternative mixed methods designs, specifying a shorthand notation system for describing the designs to increase communication across fields, visualizing procedures through diagrams, noting research questions that can particularly benefit from integration, and developing rationales for conducting various forms of mixed methods studies." (Wisdom and Creswell, 2013). The use of the chosen methods is rationalized since the mixed method research has become more interdisciplinary and the thesis data contains multidisciplinary and health practice-developing content.

The section three consists of the synthesis of the analysed data and describes the quality of the analysed data by starting with the presentation of the results of the analysis. It describes the findings emerged from selected analysis methods and briefly what the results mean. The analysis and synthesis answers questions about how the research results respond to the research questions and which topics emerged during the analysis." Synthesis involves (a) comparing (finding similarities), (b) contrasting (finding differences), (c) finding discrepancies (incompatibilities), (d) critically evaluating, and (e) interpreting the contents of the pieces accumulated for the review (Taylor, ca. 2006)." (Toronto and Remington, 2020). Synthesis entails interpreting the analysis results and explaining its significance related to research questions and placing analysis results in the context to each other. The analysis evaluates agreement and disagreement, complements to the topic or its aspects, or whether alternative perspectives can be found. The purpose is to recognize and resolve the contradictions and tensions in

the literature while recognizing consensus and general agreement. (Toronto and Remington, 2020)." Boote and Beile (2005) recommended that a high-quality literature review will move from analysis through synthesis to evaluation; it will, respectively, (a) discern the main points of each paper in the pile and (b) weave them together into new understandings, replete with (c) a critical evaluation of the ideas. This movement equates to higher and higher levels of critical engagement with the material found in the literature search ..." (McGregor, 2018).

Content analysis refers to quantitizing the qualitative data into the different categories, themes, or narratives. Critical interpretive synthesis method aims to deconstruction of research traditions and theoretical assumptions. (heyvaert et al., 2017). The analysis of the thesis tests the applicability of the research of embodied cognition to the topic and the framework it is based. After the analysis phase the phenomenon is evaluated, and the conflicting characteristics of the perspectives are examined. The integrative review proceeds from analysis to evaluation and continues the evaluation regarding methodological limitations and evaluates the implications for the research, practice, education, theory, and policy of the found information. In the fourth section the information is identified and interpreted for the reader and on behalf of the profession and provide context and meaning to the results." Review results can be displayed in a table or diagram to assist the reader in clearly seeing the details of included sources and the linkages to synthesized results (Whittemore and Knafl 2005) … Comparisons and contrasts are made of the findings of the review with background literature, and work of others…" (Toronto and Remington, 2020). The fifth stage consist of the "take home message"; the concise summary of the major finding and key contributions to the state of science. (Toronto and Remington, 2020). The study of embodied cognition, embodied music cognition as well as cognitive sciences in general has mainly based on interdisciplinary research and the scope of the thesis lies in the knowledge emerged from it.

### 1.1.1 Research Framework

Suzuki Shin'ichi developed the Suzuki teaching method after World War II in the 1940s. The method was based on the idea of rebuilding and helping families with educational matters after the war. Suzuki's basic philosophical idea serves an inspiration for the topic of this thesis. In retrospect Suzuki's teaching methods seem to have similarities to the concepts of learning emphasized today, such as Piaget's constructivist concept of learning or enactivism later emerged from the research of embodied

cognition. Holton's (2010) paper describes the connection between constructivism and embodied cognition. According to constructivism, the learner is not passive, but his or her experience is built on participation and emphasizes the student-centeredness of the learning environment. Proulx (2008) has suggested that one might view enactivism as an extension of constructivism, although there are significant differences, as well. (Proulx, 2008). According to the article (2010), the potential benefits of enactivism in education includes understanding the role of the student through embodied notion of empathy and the role of embodied notion in learning and in understanding the significance of the embodiment of teaching and learning as well as the idea of growing as a human instead just citizen. (Holton et al., 2010) Suzuki's teaching practice also includes a lot of exercises which could be called sensorimotor skills training, which closely refers to aspects of enactivism. Suzuki's philosophy emphasizes the importance of the individual and the exceptionally progressive educational idea for the time when the method was created according to which every individual can learn, and the importance of learning music lies in growing into a balanced adulthood and not taking technical skills to the extremes. The philosophy of Suzuki's doctrinal structure emphasizes a holistic conception of human. The concept of holistic health considers multidimensional aspects of wellness.

According to constructivism the truth and the knowledge construct actively and can change in time. According to constructivism learning is usually discussed through social constructivism which suggest learning being socially situated. (Gergen, 1992) Arguments in the embodied cognition theory highlight several internal and external factors playing a role in the development of cognitive capacities and bodily actions being influenced by mental constructs. (Wilson and Foglia, 2011) The philosophy of phenomenologists Edmund Husserl, Martin Heidegger and Maurice Merleau-Ponty served as the basis for what later became known as the embodiment thesis based on which also embodied cognition has developed. The phenomenological understanding of embodied cognition suggests that cognition is embodied, interactive and embedded to dynamically changing environments. Based on this belief, an enactivist understanding of cognition emphasizes the biodynamics of the organism, which participates in the construction of cognitive abilities through perception-action relation, and therefore understanding cognition requires a more detailed study of the body's sensory and motor mechanisms. (Shapiro and Spaulding, 2021) According to Wilson (2002), "successful behavior in real-world scenarios demands the integration of several sensorimotor and cognitive (as well as affective) capacities of an agent. Thus, cognition emerges in the relationship between an agent and the affordances provided by the environment rather than in the brain alone." (Wilson, 2002). The motivation for the thesis reflects the idea which argues the world of perception and the functioning of

the senses being the part of consciousness could be seeing to be having the greater importance for well-being.

The ontological basis of cognitive science and research of embodied cognition is correspondingly divided into different views and their connections about the nature of reality, partly due to the 'difficult problem' of consciousness. In the journal published in Scientific American (2019), Galen Strawson describes consciousness as the only thing in the universe whose ultimate intrinsic nature we can claim to know. (Shinozuka, 2019) In the scientific research, consciousness is divided into several areas and can be approached in many ways, of which Strawson's philosophy of approach to the mind is one of many. Science term bank (2021) defines consciousness as a subjective experience having different forms. Between physical, functional, and neurological explanations and subjective knowledge is the 'difficult problem' coined by David Chalmers in the year 1966. (Tieteen termipankki, 2021) Solving a 'difficult problem' seems to be most the fundamental issue for the study of consciousness in several disciplines. A wide variety of questions related to research of consciousness are built on top of this problem. While understanding cognition which requires considering and studying the sensory and motor mechanisms which are seen to be part of the function of consciousness through enactivism, the research emerged from the embodied cognition includes also differentiating discourses related to ultimate questions of construction and existence of consciousness and those elusive discourses can affect to the validity of the studies of embodied cognition. The elusive nature according to those ultimate questions unites the whole field of the scientific study of cognition.

According to Descartes' Cartesian dualism, the mind is separate from the body while embodied cognition rejects this view by thinking that the body and the mind are one. (Yazici, 2020) According to the view from embodied cognition consciousness is largely a continuous flow of bodily experiences and sensations (Karunamuni, 2015). Encyclopedia of consciousness (2009) describes the construction of consciousness so that reasoning clothed in the form of language is only the tip of the iceberg of the construction of consciousness referring to a metaphor that is allegedly considered to have arisen from the Freudian theory of mind. (Banks, 2009) In my opinion, mention reflects an unattainable knowledge, to the understanding or possibly the achievement of which the study of embodied cognition might provide some comprehension. Along with the discussion of embodied cognition, the discussion of the 'difficult problem' moves towards the mind-body problem, which for example raises the question of what explains mental events in the possible entity of mind and body. (Georgiev and Danko, 2020) Correspondingly, some proponents of embodied cognition such as Shaun Gallagher, Dan Zahavi and Evan Thompson see the mind-body problem as solved

because we are integrated with the experienced phenomena and our own and others' minds are just as observable as other features of the world and thus the mind-body problem only includes illusory problems. (Stanford encyclopedia of philosophy, 2021)

There are also concepts and proponents of embodied cognition, which at the same time challenge the easy solution of the mind-body -problem. Combining ontological realism and epistemological idealism has traditionally been solution of the famous philosophy Immanuel Kant (Pihlström, 2014). According to idealism the basic structure of reality is a product of the ability to know. Epistemological idealism sets the conditions for knowing and ontological realism accepts what we do not know and argues a matter of knowledge being somehow due to external unattainable realities and remain unattainable, because knowledge is created only by synthesizing ideas constructed by senses. (Guyerr and Horstmann, 2015) According to transcendental idealism, experience is constructed in the mind and reality is ontologically dependent on the mind. According to Kant, the entities formed by our senses are empirically real, determined by the abilities of thinking and intuition, and thus Kant is seen to be an empirical realist at the same time. (Adorno, 2018) According to Berendze (2023) Maurice Merleau-Ponty's early thought can be seen to arrive at ontologically similar results with Emmanuel Kant's transcendental idealism, although once he criticized idealism with aspects that are not seen as mandatory for idealism. According to Merleau's embodied idealism: "the body itself is the primary site for knowing the world, and perception as the medium and the pre-reflective foundation of experience." (Berendze, 2023).

Regarding Kant's point of view of incongruent counterparts, he struggled to explain the difference between our experience of an empirically real space has been discussed afterwards and according to Mensch (2019) philosopher Berkeley has said that the solution to the problem cannot be achieved without embodied cognition and sees Kant as having understood this point. Experiential realism is seen as a neo-Kantian creation. Experientialist position refers to a form of relativism where truth is truth in relation to an understanding that accepts the existence of alternative conceptual systems. Lakoff and Johnson have created philosophical positions that they call experiential realism, experientialism, or embodied realism. They are the following perspectives : " (R1) a commitment to the existence of the real world, (R2) a recognition that reality places constraints upon concepts, (R3) a conception of truth that goes beyond mere internal coherence, (R4) a commitment to the existence of stable knowledge of the external world but conflicts on several points with views affirmed by the dominant traditional views… Experientialism (in contrast with the dominant traditional view) holds (E1) that human reason is made possible by the body (E2) it grows out of the nature of the

organism and all that contributes to its individual and collective experience: genetic inheritance, nature of its environment, how it functions in that environment, the nature of its social functioning, etc. Hence it differs from traditional philosophy, which tends to hold that, TP1) human reason is just a limited form of transcendent (e.g., divine) reason TP2) the functions of human reason are merely a) to provide access to abstract concepts b) to provide a biological means of mimicking patterns of transcendental reason and c) to place limitations on possible concepts" (Mensch, 2019). (Mensch, 2019)

If embodied knowledge is a subjective understanding of the world based on an individual's personal observations, which is a product of the ability to know, in other words, there is no unequivocal truth, and for the same reason it is difficult to exclude an idea of the truth that cannot be accessed. This basis can be seen to mean in the study of embodied cognition that it creates the ground for understanding the individual's relationship with his consciousness and if it is the most reliable truth of the world, it is worth learning to understand and appreciate it further. By augmenting awareness of a detached realities, the only reality we can claim to know is in our (embodied) mind. According to Hardcastle (2020) the Radical thesis of cognition, which claims that cognition and consciousness are the same thing, has also been proposed to be connected to embodied cognition. However, the radical thesis has been criticized for the fact that identifying cognition and consciousness as the same would indicate that consciousness exists at multiple levels of organization in the universe, and with this, conscious cognition would have to be separated from other synergies. However, the view can be seen as offering Insights related to phenomenal experience, since neuropsychological research can provide answers precisely related to consciousness perspectives. (Hardcastle, 2020)

### 1.1.2 Embodied Cognition, Learning and Music

Embodiment thesis offers different claims and observations for cognition. According to Margaret Wilson (2002), cognition is situated, time-pressured, we off-load cognitive work onto the environment, the environment is part of the cognitive system, cognition is for action and off-line cognition is bodily-based. She states that while the first three of the claims appear to be partly true, the fourth is problematic because factors that affect the system are not necessarily seen as part of the system and the sixth claim is significant, but the least researched. According to Wilson, sensorimotor functions fall into the categories of working memory, episodic memory, implicit memory, mental

imagery and reasoning and problem solving. (Wilson, 2002) Some examples of the findings about body's role in cognition are that the position of the body can affect the felt feeling or remembering the role of the body in the experienced situation helps to remember the situation afterwards. Also, it is found that certain action verbs activate the muscles and as a result, the language is seen to be embodied rather than symbolic. (Duclos, 1989; Tversky and Hard, 2009; Glenberg, 1997) In scientific research utilizing embodied cognition and music, music can act as a tool for identifying these different bodily processes or as a tool for interaction with the help of perceptional or technological research in developing the educational or therapeutical practice.

Cognition is defined through embodied cognition firstly through sensorimotor capacities and secondly as embedded in the biological, psychological, and cultural context. According to it, activity and environment shape our experience, and this has been revealed, for example, in studies investigating mirror neurons. The theory suggests that our sensory experiences shape our thoughts and actions, and through this the physical aspects of teaching methods also affect learning. (Sullivan, 2018; Wilson and Foglia, 2011) A challenge in embodied cognition research is the overlap of different views in research for example related to extended cognition and situated cognition. Embodied cognition is closely related to the extended mind thesis, situated cognition, and enactivism. Because of this, embodied cognition can be seen more as a research program than unified theory. Acquiring information by utilizing the perspective of embodied cognition requires understanding adaptive behavior, which is also called autopoiesis, as well as understanding information processing in relation to the environment and exploring and modifying the environment. (Wilson and Foglia, 2011) Extended mind thesis refer to the expansion of cognitive processes outward into the agent's world, i.e. the mind extends into the physical world, while situated cognition draws attention to the cognitive processes taking place as part of the cultural and social environment, where changing interactions with the environment play an important role. (Shapiro, 2019)

Research on embodied cognition and the theory of enactivism have found that sensory behavior and cognition are connected, if not inseparable. (Holton, 2010). As mentioned, enactivism has emerged from embodied cognition: "For the enactivist the body is the ultimate source of significance; embodiment means that mind is inherent in the precarious, active, normative, and worldful process of animation, that the body is not a puppet controlled by the brain but a whole animate system with many autonomous layers of self-constitution, self-coordination, and self-organization" (Witherington, Heying, 2013) Enactive thinking includes the concepts embodied, embedded, extended and enactive. All concepts provide explanatory models for cognitive processes. Enactivism is divided into trends such as radical enactivism, sensorimotor

enactivism and autopoietic enactivism. (Anttila, 2022) Embodied as a concept refers to cognition involving the entire body of the living system and not just the brain. Embedded describes the stratification of physical, social, and cultural aspects in the cognition process. Enactive as a concept describes an active interaction process through cognition. (Schiavio and Schyff, 2018) In radical enactivism, predictive processing plays major role and cognition is based on the idea that representations are not an essential constituent of cognition. (Gärtner and Glowes, 2017) According to sensorimotor enactivism, experience is not seen to be formed by extraperceptual interactions and the affective dimension of perception lies in the perceptual engagement. Autopoietic enactivism claims that there is a necessary and constitutive relationship between conscious experience and autopoietic processes or their background capacities. (Degenaar and O'regan, 2017)

According to Leman, Maes, Nijs and Van Dyck (2018) embodied music cognition suggests that music processing is based on corporeally mediated interactions with music. Man has been found to be incapable of perceiving the state of the world directly, and the true still unknown state must be inferred from the information that proprioceptive and exteroceptive corporeal mediators provide. An article by Leman and colleagues (2018) reveals how the perception of the body's involvement in perception has changed from the idea that bodily involvement is part of the perception to bodily involvement shaping the way we perceive. "Embodied music cognition draws attention to the fact that the predictive model is largely the result of the constraints of the mediators and the listener's own corporeal states (Leman, 2007)." (Leman, Maes, Nijs and Van Dyck, 2018) The study of embodied cognition helps to understand the underlying causes and consequences of bodily interaction, distinguishing between skills and knowledge, bodily mediators, and states of being. Musicology has considered the subjects according to embodiment before from the different perceptions and theories but studying embodied processes from the perspective of embodied cognition, we can simplify our understanding of the nature of the body and become more aware of the factors and goals that affect learning and being. (Leman, Maes, Nijs and Van Dyck, 2018) I believe that by understanding the nature of the body in being, we can also understand more diversely the causes and consequences influencing the occurrence of musculoskeletal problems and motivational factors preventing them.

A common scientific discussion between the embodied music cognition paradigm and the classical cognitive paradigm is that the classical cognitive paradigm is said to neglect the effects of sensory processing in tonality perception. In the embodied cognition for example processing like anticipation needs to be conceived in terms of schemes that combine perception-related issues with sensorimotor-related issues. This connection and the sensorimotor effect in the interaction are called enactment."

Enactment may be seen as a method for realizing an intentional outcome. Basically, this means that corporeal interactions determine prediction models for the ongoing and future interactions with music, so that music can be conceived in terms of goals, directions, targets, values, and reward." (Leman, Maes, Nijs and Van Dyck, 2018). Example of the sensorimotor effect is the study of subjective effectors. "…predictions can be based on particular bio-mechanical properties of the bodily effectors, such as the propensity for 2 Hz resonances…" (Leman, Maes, Nijs and Van Dyck, 2018). The second common concept in embodied music cognition is entrainment, which refers to the activating effect of music. For example, in the Leman and others study (2013) music's expressive and acoustic properties were seen to affect to the speed of walking in which the binary and ternary arrangements plays an important role in music's effectiveness. (Leman, Moelants, Varewyck, Styns, van Noorden and Martens, 2013)

According to Kang and Tversky (2016), gestures convey spontaneous movement and can represent or resemble action. In addition, gestures can describe a wide range of meanings more directly than language, describing concepts congruently. (Kang and Tversky, 2016) In the study of musical gestures, decoding (expression-responding gestures) refers to events during listening and encoding (expression-supporting gestures) action during music performance. In both situations, expression is seen to move from gesture to music or the other way around, and it implies a mirroring between qualities of the sound and movement patterns. (Leman, Maes, Nijs and Van Dyck, 2018; Leman and Jan-Maes, 2014) In studies combining learning with embodied cognition, an emphasis on gesture research seems to be a prominent trend. According to Sullivan (2018), Shapiro and Stolz (2019) and Kosmas and Zaphiris (2019) learning methods combining learning and embodied cognition can be divided into human-centered or technology-centered methods. Human-centered methods can include a gesture study emphasizing the use of dynamic descriptive gestures, exercises related to thinking with gestures or metaphorical gestures. In addition, self-organization, visual stimulation, imitation, active object manipulation or motor involvement are common concepts in the context. In technology-centered studies virtual reality or embodied games and artifacts are emphasized. (Sullivan, 2018; Shapiro and Stolz, 2019; Kosmas and Zaphiris, 2019)

The educational questions from the perspective of embodied cognition can focus on the socio-material perspectives emerged from enactivism. According to the socio-material approach, learning is the interweaving of non-human and human activities, and thus knowledge is also built into the surrounding reality through materiality and sociality. Sociomaterial theories focus on explaining the described interaction. Emergence is a concept used in the approach to describe the unpredictable events of interaction and learning as a continuous process of exploring and inventing. (Anttila, 2022)

Lesaffre's (2018) article emphasizes the multidisciplinary possibilities of embodied music cognition in the field of health and well-being, for example in connection with various health disorders, aging, disability, for example in music therapy interventions. (Lesaffre, 2018) According to (2018; 2016; 2017) studies combining music, learning and embodied cognition can focus on the emotional component of music education through concepts like sensorimotor exploration, expressivity, motor adaptation, skilled coping, motor simulation (reproduction in movements and gestures) or relational system and expressive gestures. Learning can be seen as a long-term process through interactive, improvisational, and informal musical learning. Methods which are seen emphasizing enactive aspects are, for example, Dalcroze, Orff, Kodai and Cohen. (Schiavio and Schyff, 2018; Maes, 2016; Nadyrova, 2017) Based on the mentioned studies about music and learning, I see that the prevention of musculoskeletal disorders could be suitable for the field of multidisciplinary health and music research through embodied cognition, considering also the more comprehensive support of motor skills and growth, learning motivation, and psychosocial and cognitive load factors.

## 1.2 The Current Study

Based on section 1.2.1.1, the need for inclusion of clinical research and the need for prevention interventions and programs has taken attention away from the learning environment and a clear gap regarding research related to the learning environment and prevention can be concluded. According to Agostini and Francesconi (2021), "What is still missing, however, is a solid reflection of the encounter of embodied cognition and educational science within a phenomenological perspective. So far, only a few attempts to elaborate a theory in this sense have been made" (Agostini and Francesconi, 2021). Based on the preliminary search, it is also possible to find useful points between prevention of musician's musculoskeletal problems and embodied research on learning, especially when focusing on playing-related causes. According to my evaluation prevention can be developed with the help of ideas emerging from the theory of embodied cognition. Research of the embodied cognition can help to understand the autonomy of the body and experience as a part of the socio-cultural environment and its role in the causes and consequences and in the mentioned proposals, and thereby understanding the emergence of attitudes towards the overall well-being. The results of the studies suggest cautiously that embodied cognition can be a good

basis for examining the preventive role of music from a perspective that is closer to a music professional who is not a professional in the health field.

The challenge finding studies combining the three themes of the thesis was prominent based on the preliminary review and because of this, it remained to be evaluated how the topic is combined or can be combined. The studies of the tables in section 1.2.1.2 are united by the message of openness towards the body's sensorimotor and autopoietic nature when developing teaching and learning. Prevention could be taken as a part of self-organizing activities and with this, an understanding can be created about how prevention could be approached through self-organizing activities, for example through adaptive stability or openness to examining internal and external factors from the perspective of prevention. According to section 1.2.1.3 and finding main categories that require a more detailed breakdown has been found and the results were able to point out themes that could be included in the development of preventive practice with the embodied cognition thesis. Based on the findings of the preliminary review section 1.2.1.1 and 1.2.1.2 major topics of prevention of musician's playing-related musculoskeletal problems is divided into eight main sections; 1) The Role of Movement and Ergonomics 2) Relaxation, 3) Aspects related to Cognitive Functioning 4) Psychological, Social and Sociocultural Factors 5) Growth and Development and 6) Embodied and Enactive Methods and Preventive Programs.

### 1.2.1 The Preliminary Review

Section 1.2.1 explores and charts the background factors of musician's musculoskeletal problems and how embodied science is applicable in educational practice development and the role of embodied science in the development of preventive musical practices. The preliminary review describes and defines the problems, gaps in the topics of the different sections with the aim of creating a basis for synthesis. The description of the symptoms of musician's musculoskeletal problems in the first section 1.2.1.1 shows the direction of how the subject has been treated in the past few years and which factors educators working with music could pay attention to in the future. The second section 1.2.1.2 gives a picture of how embodied cognition has been seen in the learning environment and in interpretations of the concept of learning. The third section 1.2.1.3 examines the prerequisites for how the first and second sections may meet when developing the whole; embodied cognition in prevention of musician's musculoskeletal problems in learning environment.

#### 1.2.1.1 Prevention of Musician's Musculoskeletal Problems

| | (Zara and Farewell, 1997) | (Rotter, Noeres, Fernholz, Willich, Schmidt and Berghöfer, 2020) | (Cruder, Barbero, Koufaki, Soldini, and Gleeson, 2020) | (Foxman and Burger, 2006) |
|---|---|---|---|---|
| Symptoms | PRMD typically affect the neck, back, upper extremities, and facialmusculature | Performance-related hand problems, temporomandibular disorder (TMD), facial pain, neck pain, disorders in upper extremity, chronic pain, median and ulnar neuropathies, functional disorders, anatomical abnormalities, shoulder impingement syndrome, occupational injury | psychosocial stress symptoms | performance anxiety, tinnitus, noise-induced hearing loss, fatigue, circadian rhythm disruption, wrist tendonitis, tenosynovitis of the digits, carpal tunnel syndrome, soft tissue and nerve entrapment conditions |
| Risk factors | women gender, subjective factors, abrupts increase in practice time, playing-related behaviors | gender, age, chinrest type, practice time, disabilities, physical and mental health indicators, radiological abnormalities in the temporomandibular condyle, disorders of the locomotor apapratus, flexor muscle behavior, elevated arm position, high somatization | first or second year master's student, years experience extertion after 45 min without breaks | awkward posture, postural stress, under report symptoms for fear of a career-ending disability |

| | | | | |
|---|---|---|---|---|
| Suggestions | farming up, taking breaks and prevention programs | (TMD) related to musician's performance anxiety (MPA), lack of studies related effectiveness of the prevention or treatment of MCD, cohort studies and randomized confirmatory intervention studies needed | targeted interventions, prevention and treatment strategies | Some musicians accept musculoskeletal pain as a normal and necessary, biom-mechanical training, farming exercices, Secondary prevention measures including early diagnosis and aggressive treatment, Alexander technique, Feldenkrais -method for relaxation, body awareness, optimal instrument condition, proper seating and lighting, neutral posture, Breaks of 10 to 15 minutes should be takenevery 30 to 60 minutes during practice sessions |

Table 1 Prevention of Musician's Musculoskeletal Problems

In terms of symptoms, the general validity of the results and the level of detail in relation to the year in which the study was performed are noteworthy. The study (1994) addresses the problem of upper extremities, which plays a major role in the clinical diagnosis of the most common musculoskeletal problems later identified, and problems in upper extremities. For example, overuse syndrome which referres to upper extremities dominates the symptoms and risk factors of all four studies. Although the studies in the table can only serve as a guide to the phenomenon at hand due to their scarcity, none of the studies comparing these studies had a greater emphasis on psychosocial factors, although mental factors were noticed in the risk factors. According to the Leman and others study (2018) addressed in the earlier sections, embodied music cognition, which is rooted in motor behavior, is composed of many sensorimotor, affective, and cognitive systems and is influenced by many environmental factors. (Leman, Maes, Nijs and Van Dyck, 2018) Embodiment is such a multidimensional and intimate component of a physical existence that I see consideration of its connection to the subject as important in research and practical development that prevents musculoskeletal problems as the other suggestions. As mentioned in section 1.1.2, I see

embodied cognition potentially a considerable tool for developing understanding about psychosocial stressors in musician's learning environment.

Time is also a dispensable part of music entirety and in receiving information from the outer world. Between the research articles presented in the table related to musician's musculoskeletal problems are a strong connection in the results indicating to factors related to timing in practicing. Ambit of "now" in the present seems subjectively variable. (Clarke and Clarke, 2011, s. 8) According to article of Droit-Volet, Ramos, Bueno and Bigand (2013), music perception and emotional valence has connection in time perception. (Droit-Volet, Ramos, Bueno, Bigand, 2013) Time perception could be a theme that is brought from classical cognitive theory to embodied science. When addressing psychophysical and psychosocial factors in the development of preventive practices, it could also be useful to consider time perception for understanding the subjective (for example related to personality) relationship between time perception and habits of time use. It could be justified in this context to assess endogenous and exogenous embodied effects for time perception in the context of embodied cognition. The concept of exogenous embodiment refers to embodied effects that have an exogenous origin. The concept of engenous embodiment refers to embodied effects from the endogenous origin. (Kelly-Irving and Delpierre, 2021) Exogenous embodiment includes studies related to subjects such as teacher's gestures and imitation. Both perspectives necessarily influence each other in perception, which partly describes the scope and essence of embodied cognition.

Playing-related musculoskeletal disorders often referred to by the acronym PRMD are the most common of the musicians playing -related problems. Studies often differentiate between playing-related and non-playing-related symptoms. The musicians' diseases can be divided into organic and non-organic problems. "In organic problems, there can be tenosynovitis, hypermobility syndrome (HMS), arthritis and so on. On the other hand, non-organic problems such as overuse syndrome and focal dystonia are more work-related. These lack of specific treatment and are generally treated conservatively. " (Lee, Park, Yoon, Kim, Chun, Aminata, ... and Jeon, 2013) Rotter and colleagues (2020) refer to the problem in terms of complaints and disorders (MCD), musculoskeletal problems are referred to both (MSKP) and (PRMD). (Rotter, Noeres, Fernholz, Willich, Schmidt and Berghöfer, 2020). In the development of specific preventive practice, the challenge is to identify the diversity of terminology and to distinguish the underlying causes of a particular symptom, so that practical exercises also serve more specifically but also, above all, do not cause problems due to targeting. In this context, a holistic perspective is valuable, so that the extent of cause-and-effect relationships and the diversity of clinical terminology can be made aware, and on the

other hand, the topic can be narrowed down and targeted to serve the field of education as the preventive embodied policy is developed.

The study by Zara and Farewell (1997) already saw the need to investigate the relationship between psychological and physical problems in relation to musculoskeletal problems, for which there was a gap in the literature on the whole and which could be said to still exist. Occupational medicine also provides answers related to risk factors, as many of the problems of musicians are common in other fields as well. "Extensive research on several groups shows that force, repetition, and posture are associated with an increased risk of work-related musculoskeletal disorders (Moore et al., 1991; Armstrongand Silverstein, 1987; Stock, 1991). "(Zara and Farewell ; 1997) The Alexander technique emphasizes bodily awareness learning. (Foxman and Burger, 2006) As mentioned in a clinical study (2006), the pursuit of neutral movements and postures is important for exercise. (Foxman and Burger, 2006) I see that the study of embodied music cognition could help to understand subthemes like body awareness as well as striving for neutrality in the development of preventive exercises. Clinical research helps to understand diagnoses and areas of influence in the body from the inner causes, and I see that embodied music cognition can also be used to understand the emergence of diagnoses from the perspective of developing diverse creative education.

| | (Lee, Park, Yoon, Kim, Chun, Aminata, ... & Jeon, 2013) | (Russell and Benedetto, 2014) |
|---|---|---|
| Symptoms | overuse syndrome, muscle-tendon syndrome, focal dystonia, hypermobility syndrome, and compressive neuropathy, nerve compression syndromes, degenerative conditions, tenosynovitis, hypermobility syndrome (HMS), arthritis, osteoarthritis, thoracic outlet syndrome and rheumatoid arthritis, muscle-tendon strain (most common), cubital tunnel syndrome | experience of discomfort |
| Risk Factors | isotonic and isometric movements, overuse syndrome (most common cause), hypermobility syndrome, old | lower graders had more discomfort related to higher grades, too early use and too repetitive use of techniques |

| | | |
|---|---|---|
| | injury, accumulative physical stress, inflammation conditions | requiring relaxation and fluidity, gender was not a significant |
| Suggestions | 'Groningen Exercise', absolute rest | relationships between the enjoyment of the instrument playing, stress about playing, string class frequency to reported discomfort, physical and musical exercises |

Table 2 Prevention of Musician's Musculoskeletal Problems (2)

Between the studies presented in the second table related to string players musculoskeletal problems are found a strong connection in the results indicating to the connection between relaxation and stress. The studies are not validly comparable in the sense that one study deals with symptoms and the other with discomfort. Study of Russell and Benedetto (2014) sample was from adolescents and children while Lee and colleagues study (2013) sample was from professional musicians. It is noteworthy, however, that the 2014 study (2014) did not find very serious experiences about discomfort, but in adulthood the symptoms may already be severe. This indicates that the symptoms develop over a long period of time and it is justified to examine the possibilities of prevention from the perspective of addressing the symptoms at an early stage and before them. The research was conducted as a survey and in this case, too, the student's knowledge of his own body played an important role. (Russell & Benedetto, 2014 ; Lee, Park, Yoon, Kim, Chun, Aminata, ... and Jeon, 2013) The study of Lee and others (2013) was the only one of the studies in the tables that presented a special exercise in addition to the rest in its results, although the study Foxman and Burger (2006) offered mentions about the Alexander method as well as the Feldenkrais method. For future work, it could be useful to bring together the developed exercises and evaluate their priorities from the perspective of embodied music cognition. (Lee, Park, Yoon, Kim, Chun, Aminata, ... and Jeon, 2013; Foxman and Burger, 2006)

About future implications of the research articles in the tables, the need for preventive strategies and interventions is considerable. Based on both tables, it could be estimated that it may be desirable to consider subthemes such as body awareness, natural movement and physical requirements when developing embodied music education, distinguishing between playing-related and other causes when assembling symptoms and causes, and include and combine psychosocial and physical factors from the view of the embodied music cognition. Of the studies in the tables, the study of Russell and

Benedetto (2014) is the only one considering social factors separately in the phenomenon. Although it specifically addressed discomfort, social factors are also involved in the emergence of musculoskeletal problems. It can be inferred from the tables that there is an overlapping between symptoms and risk fac tors., For example an inflammatory condition may be a cause or a consequence. This should also be taken into account when justifying the practice. Finally, when dealing with prevention, in synthesis it is good to distinguish between suggestions that refer to primary, secondary and tertiary prevention even they would not be named by these terms in the studies.

Based on the studies selected for the preliminary review, the most common risk factors from organic background for musculoskeletal problems are hypermobility syndrome, radiological abnormalities in the temporomandibular condyle, disorders of the locomotor apapratus, flexor muscle behavior, high somatization, physical and mental health indicators, gender, age, disabilities, subjective factors. (Lee, Park, Yoon, Kim, Chun, Aminata, ... and Jeon, 2013; Rotter, Noeres, Fernholz, Willich, Schmidt and Berghöfer, 2020; Zara and Farewell, 1997). The non-organic factors emerging from the studies were too early use and too repetitive use of techniques requiring relaxation and fluidity, isotonic and isometric movements, overuse syndrome (most common cause), old injury, accumulative physical stress, inflammation conditions, awkward posture, postural stress, under report symptoms for fear of a career-ending disability, first- or second-year master's student, years experience extertion after 45 min without breaks, elevated arm position, chinrest type, practice time, women gender, abrupts increase in practice time, playing-related behaviors. (Russell and Benedetto, 2014; Lee, Park, Yoon, Kim, Chun, Aminata, ... and Jeon, 2013; Foxman and Burger, 2006; Cruder, Barbero, Koufaki, Soldini, and Gleeson, 2020; Rotter, Noeres, Fernholz, Willich, Schmidt and Berghöfer, 2020; Zara and Farewell, 1997). Rewiewing the selected studies, the amount of the non-organic factors is larger. The factors in themselves are not comparable in terms of effectiveness, because organic factors can be more difficult to determine and can be the cause of more symptoms than non-organic. However, in terms of validity, it is more justified to focus on non-organic factors in non-clinical studies.

Due to the small number of selected reviews, generalizability is not possible. However, how the latest studies shift the focus to the need for inclusion of clinical research and the need for prevention interventions and programs can be instructive for understanding the shift away from the learning environment in focus in general. In my opinion, some of the selected research's suggestions and outcomes can serve as justification for the need to consider also the benefits of embodied cognition for the development of preventive practices for learning environment. For example the proposals referred to

the attitude towards pain, enjoying music, the necessity of methods arising from embodied study, neutrality, rest and body awareness. (Russell and Benedetto, 2014; Foxman and Burger, 2006). Research of the embodied cognition can help to understand the autonomy of the body as a part of the socio-cultural environment and its role in the causes and consequences and in the mentioned proposals, and thereby to understand the emergence of attitudes towards the overall well-being. In my opinion, the results of the studies suggest that embodied cognition can be a good basis for examining the preventive role of music from a perspective that is closer to a music professional who is not a professional in the health field.

#### 1.2.1.2 Embodied Cognition in Learning Environment

| Embodied cognition / Learning | (Sullivan, 2018) | (Shapiro and Stolz, 2018) | (Kosmas and Zaphiris, 2019) |
|---|---|---|---|
| Orientation | teaching and psychology | education and psychology | technology, education and pedagogy |
| Subjects | human-centered methods : visual stimulation, gestures and imitation, active object manipulation, motor involvement / technology-centered methods : critical study needed, virtual reality | gestures, self-organization, discordance and concordance, thinking with gestures, dynamic depictive gestures | embodied interaction, embodied learning, kinesthetic learning, applications : tangibles, kinect/wii, embodied artifacts, biosensor, embodied games |
| Approaches | learning environment (embodiment in the classroom), exogenous embodiment, student experience | historical overview, educational implications for teachers | integration of the embodied research methods and technologies to learning contexts |
| Benefits | explicit and implicit memory, elaborative memories, later structuring and recognition of the learned | physical experience enhance learning concepts, gestures contributing information, discordance refers to openness for learning, body being supplement or substitute for knowledge and a tester of ideas | gestures attract attention from learners and stimulate thinking, movements also help to attract attention, encode information, and facilitate the communication and interaction between learner, technology and environment |

| | | | |
|---|---|---|---|
| Suggestions and implications | implementing understanding from human methods to passive forms of learning | gesture–speech and cues of mismatches, encouraging to imitate and produce gestures, categorazing the gestures, embodiment for measuring conceptual understanding / interdisciplinary studies | cognition is affected from different systems : clear separation of cognitive areas, more theorethical approaches |

Table 3 Embodied Cognition in Learning Environment

The definition and interpretations of learning have changed with the research on embodied cognition and it has an impact on educational settings. In the embodied approach to learning theory, cognitive mechanisms are linked to human interaction with the environment. Although the studies in the table were conducted in close years, there are differences in terminology and perspectives related to the topic. However, the subjects are all united by educational and gesture-related perspectives. The articles also include an understanding of the effect of the body on information processing. The functions of the body can support memory, stimulate thinking, and act as a supplement to information, a substitute and a tester of ideas. Sullivan's (2018) article presents human-centered and technology-centered methods. Shapiro and Stolz (2018) has a human-centered perspective and article from Kosmas and Zaphiris (2019) focuses on the technology perspective. These differences reflect the multiplicity and diversity of interpretations within the topic of embodied cognition and learning. Based on the articles, the goals in studies dealing with embodied cognition and learning may be related to the development of multidisciplinary research, bringing human-centered methods and an understanding of embodied cognition into a passive learning environment, handling gesture research separately from the perspective of the learner and the teacher, a more precise understanding of different areas of cognition through embodied cognition, and the development of theory. (Sullivan, 2018 : Shapiro and Stolz, 2019 : Kosmas and Zaphiris, 2019)

The study of Maturana and Varela (1987) sees importance in learning in integrating first- and second-hand knowledge and describes the learning ; “learning is contingent upon the cognitive activity that is triggered by the environment and is determined by the dynamic nature of living beings engaged in the self-organizing activities by which they sustain themselves” (Maturana and Varela, 1987). Shapiro and Stolz research article (2018) adress recent educational implications of embodied cognition and names the area as embodied education. Research suggests that embodied cognition significance in education is a perspective on, for example, how a teacher intuitively

recognizes the contradictions in a child's gestures. « Discordance is a sign of readiness to learn because it indicates the presence of an idea that is not quite available to the subject's conscious awareness... teachers who display discordance benefit student learners because they expose them to a range of strategies in the gestural modality, thus teaching them how to 'think with gestures'» (Shapiro and Stolz, 2018) Other important aspects based on gesture research were, for example, encouraging to gestures, as it helps in the ability to communicate information and promotes learning. (Shapiro & Stolz, 2018).

Embodied cognition research on learning emphasizes the concepts according to dynamic interplay, sensorimotor experiences as an example of the meanings of the word linked to sensorimotor experience and the idea whereby everyone can learn through imagination, demonstration and testimony. The methods used in learning research are related for exmaple to learning subjects, tools, learning outcomes and effective integration of body in learning environments. Embodied cognition theory alone gives rise to different concepts of learning for different educational goals. These include embodied learning, kinesthetic learning and embodied interaction. Embodied learning refers to the idea that people have a reflective mind, sensorimotor bodies and are social beings. Kinesthetic learning refers to a learning environment where the learner physically interacts with the learning experience and perception includes sensory and motor processes. Kinesthesia refers to the movement sense. From the previous century, Montessori education included methods that were used to promote learning through kinesthetic engagement. Embodied interaction refers to interactions between body objects and space, and context usually occurs in research of human-computer interaction. (Kosmas and Zaphiris, 2019) "application areas of embodied and HCI are: a) Educational and online systems, b) Cognitive design and robotics, c) Autonomous Agents and, d) Cognitive Interfaces." (Kosmas and Zaphiris, 2019).

| | | | |
|---|---|---|---|
| Embodied cognition / Learning / Music | (Schiavio and Schyff, 2018) | (Maes, 2016) | (Nadyrova, 2017) |
| Orientation | interdisciplinary, music, learning, behavioral science | interdisciplinary, music, learning, psychology | teacher education |
| | review article | review article | book chapter |
| Research perspective | 4E principles of cognition: embodied, embedded, extended, enactive / self-organization, | dynamical system theory (assembly, self-organization, stability, constraint- and | enactivism of music education and training, situated activity of |

| | | | |
|---|---|---|---|
| | autopoiesis (enactive) / interaction theory, hybrid extended cognitive systems / | processes-based), predictive coding | "teacher-educator/teacher-researcher", |
| Subjects | creativity, collaboration, the role of movement and the situated body for learning / sensorimotor exploration, skilled coping, interactive, improvisational and informal musical learning | emergent timing system, the Bayesian brain, internal model, prediction, error-correction, and motor adaptation, role of long-term processes involving learning and prediction | expressivity, emotional component of music education, motor simulation (reproduction in movements and gestures), embodied simulation (relational system and expressive gestures), enactive approaches: Dalcroze, Orff, Kodai, Cohen |
| Approaches | 4E and autopoiesis helps to understand the contingent and creative nature of musical development /music education environments as self-organizing and autonomous systems / learning music: bidirectional dynamic where action and perception are coupled | "radical" embodiment thesis to music cognition and interaction: music perception and performance lie in sensorimotor dynamics and predictive processing | multidisciplinary convergent analysis and synthesis: highlights the role of student's gestures involving, gesturing for to embody the nature of music style and phrasing, from speculative approach to experience of active action |
| Suggestions and implications | general principles for development, bio-ethical implications for pedagogy, understanding empathic processes through affective interactivity | practical research, time-dependent changes, variability, and non-linear complexities with dynamical systems analysis | active recognition of enactivism and mirror mechanism in music education, experimental research carried out by teachers in practical development |

Table 4 Embodied Cognition in Musical Learning Environment

Studies involving embodied cognition, learning and music often process learning through exogenous environment and mirror neurons according to teacher's representative gestures, visual stimulation, imitation, grounding knowledge in motor experience in active learning and suggests examining sensorimotor information in development of instructional methods. (Sullivan, 2018) The article of Schiavio and Schyff (2018) offers a fair number of explanations of practical and related concepts and theories for study of learning and embodied cognition such as functionalism to 4E

Cognitive science, interaction theory, self-organization (autopoiesis), brainbody-world system, hybrid extended Cognitive systems, expert-intuitive performance (note not unconscious), flow, skilled coping, sensorimotor exploration, proto-musical actions, M4M and Cognitive ecology. In the article empathic processes are explored first in terms of embodied affective interactivity that allows for shared understandings to develop between autonomous agents. (Schiavio and Schyff, 2018) The concepts in embodied cognition related to learning are diverse and identifying in which context they are being referred to is necessary. The article focuses on utilizing the body's autonomous functions in teaching. « an open horizon of relationships and possibilities is disclosed and enacted: the body does, the body feels, the body predicts and anticipates; it has certain layers of autonomy that can lead to new meaningful interactivities with the musical instrument, without involving mental plans, rules, or normative domains" (Schiavio and Schyff, 2018).

In addition to perceptual factors, a distinction must be made between internal and external factors affecting the learning experience, such as cognitive states or teacher's gestures. In Sullivan's study (2018), the embodiment from the view of practical development has been addressed from the perspective of external and physical factors affecting mental experience and this is referred to as the exogenous embodiment while Schiavio and Schyff's (2018) article conveys the learning experience from a perspective where music education environments should be considered as self-organizing and autonomous systems and it emphasizes situated cognition in learning. The scientific message of the Schiavio and Schyff article (2018) is that if learning is a self-generating activity, that develops and adapts sensorimotor engagement models to understand the world, then the role of the sociocultural environment must be taken seriously in developing pedagogical strategy. (Sciavio & Schyff, 2018 ; Sullivan, 2018) Although the distinction is important for the sake of clarity, in the learning environment external and internal perceptual factors are mixed in the learning experience. For example, according to Wilson's article (2002), the role of the environment can also be seen as part of the cognitive strategy in offloading the work, and the article describes the natural human need to use rotation and translation movement rather than mental computing to simplify the problem to be solved. (Wilson, 2002) From the autopoietic perspective, a wide variety of biological and non-biological entities and devices can help in performing cognitive functions and in active sense-making. (Schiavio and Schyff, 2018)

The prerequisite for the utilization of autonomous functions is the integration of the different sensorimotor and cognitive (as well as affective) capacities of an agent and taking into account the relationship between an agent and the affordances provided by the environment. Hybrid extended cognitive systems also refers to implications for

teachers as a way to explore 'hidden' relational aspects of the music and creating novel ways to express the practice starting with interactive, timbral and improvisational aspects. In the article, the skill in which a learned musician uses his intuitive knowledge is called skilled coping. (Schiavio and Schyff, 2018) In terms of developing the embodied music education, it can be useful to deal with these components separately in terms of understanding the whole and to understand the differences and possible points of convergence between the concepts and to find influential subthemes in the components. According to Crawford (2022) sensorimotor processing includes effects of external physical stimuli, feeling internal sensations, evaluating the senses and producing a motor response. Sensorimotor exploration as a concept refers, for example, to the fact that a musician finds interpretation possibilities that go beyond imitation. Sensorimotor skills (2022) involve receiving sensory messages through our sensory system, which includes sight, hearing, smell, taste, touch, vestibular and proprioception. According to Kiely (2014) cognitive capacities refers to skills related to information processing, such as learning, attention, perception, memory, decision making and language abilities (Crawford, 2022 ; Schiavio and Schyff, 2018 ; North Shore Pediatric Therapy, 2022 ; Kiely, 2014) It could be useful to consider motivational means familiar to music pedagogy, such as metaphors and imagination, through the perspective of autopoietic enactivism.

According to Nadyrova (2017) the idea of enactivism has been intuitively used in development of many methods born in the last century, as is evident in Vetlugina's (1968) description of various exercises in his book, such as free conducting, plastic intonation, the reception of musical mirrors, the game « echo », imitation, etc., which refer to those born from enactivism to thoughts. (Nadyrova, 2017) These mentioned exercises have a lot in common with the exercises of Shin'ichi Suzuki's method born in the 1940s. In both and many other methods mentioned in this thesis, such as Dalcroze, Orff, Kodaly, Cohen, Alexsander and Feldenkrais the teaching is based on the child's different forms of motoric participation in music in perception and experience processes. According to Nadyrova (2017) motor simulation and use of gestures are common practices in music pedagogy. Nadyrova's research deals with the same theme and states that enactivism can help to verbalize the ideas and practices behind these methods and many times the previously developed practices have bypassed scientific research. The perspective of the enactive approach can also help to better understand the physiological and psychological mechanisms of students. Nadyrova emphasizes that the understanding of methods among teachers is facilitated by clear scientific justification and the presentation of concepts and methods connected to enactivism. (Nadyrova, 2017)

Concepts that are close in meaning when referring embodied cognition and learning such as unconscious, subconscious, and intuitive knowledge or processes, can be misleading in a scientific text. The possible connections to theories linked to embodied cognition are interesting and according to preliminary research, little discussed. "Embodied cognition is related to conditioning because it operates at a subconscious level and is automatic" (Colloca and Howick, 2018). According to Rosenblatt and Thickstun, intuition represents an unconscious cognitive activity the results of which will become known later (Rosenblatt and Thickstun, 1994). Subconscious processing, on the other hand, is seen as belonging to the area of consciousness, but we are not actively aware of its operation, and intuition is the ability to access information processed by the subconscious mind. (Rosenblatt and Thickstun, 1994; Sobkow, Traczyk, Kaufman, and Nosal, 2018) Unconscious processes has been discussed in Shiavio's and Schyff's article (2018) with enactivism, urging to be careful not to call the autopoietic processes of learning unconscious, but rather a situation-specific way of coping. (Schiavio and Schyff, 2018) Maes's article (2016) again refers to unconscious behavior when teacher immediately learns to understand something while evaluating a student. (Maes, 2016) Nadyrov discusses intuition in connection with skilled coping and autopoietic enactivism. (Nadyrova, 2017) Subconscious processes are not referred to in the studies in the table. In other words, Colloca and Howick's (2018) description of embodied cognition could suggest that it operates at subconscious and unconscious level. According to my opinion, mentioned terms relating to autopoietic processes could be referred to in practical work as a skill to help understand complex and demanding issues and to make quick decisions. Before that clear differences between concepts must be ensured or use concepts which better describe the autopoietic nature of embodied processes. (Colloca and Howick, 2018)

The themes covered by the studies in the table to be developed in teaching from the perspective of embodied cognition include creativity, improvisation, skilled coping, expressivity, motor simulation (reproduction in movements and gestures), embodied simulation (relational system and expressive gestures), methods of enactive perspective, interactivity, collaboration, the role of movement or long-term processes and prediction. Schiavio and Schyff's article (2018) is based on situated cognition, according to which knowledge is situated in action that is tied to social, cultural and physical context, while Maes's article (2016) is based on a radical embodiment view, which according to Raja (2021) is based on rejection of the use of computational mechanisms and representations to pursue explanations and cognitive processes are best understood in terms of dynamical explanations. (Schiavio and Schyff, 2018 ; Maes, 2016 ; Raja, 2021) Consideration's to the development of practices in the studies of the table include mirror mechanisms or the role of interactivity in understanding empathic

processes, active recognition of enactivism, general principles for development, bio-ethical pedagogic implications, practical or experimental research, time-dependent changes and variability. (Schiavio and Schyff, 2018: Maes, 2016: Nadyrova, 2017)

> 'All doing is knowing, and all knowing is doing' (Maturana and Varela, 1987: 26). (Sullivan, 2018)

The quote above is a clear description of the autopoietic nature of the body. The studies of the tables are united by the message of openness towards the body's sensorimotor and autopoietic nature when developing teaching and learning. It can affect the teacher's role in such a way that the environment becomes more balanced and equal. Depending on the developmental state of the student the teacher can provide an understanding of the autopoietic nature of the body with the help of intuitive exercises without unnecessary explanations or enlightening the student of the underlying mechanisms affecting to it. According to Nadyrova (2017) the teacher can help the student to maintain their adaptive stability and flourish as autonomous musical beings. (Nadyrova, 2017) Just a change in the attitude towards learning and teaching can change the attitude towards the fundamental questions of the meaning of learning and being human, in addition to increasing the teacher's readiness to develop new perspectives more openly on teaching and what kind of internal or external factors are fruitful to utilize in terms of development. Everyone is united by the idea of moving from a speculative nature of teaching to an understanding of cognitive function of the body and active participation.

#### 1.2.1.3 Embodied Cognition in Preventive Practice Development

According to Black (2012) the richer the perceptual environment is using multiple sensory modalities (e.g., using visuals, voiceovers, and movement) during initial learning the better the student learning, understanding and motivation is. (Black, 2012). The perspectives of the previous section aim to understand the contingent and creative nature of musical development and in practice the utilization of the perceptual environment in creative ways is emphasized. I evaluated the possibilities of teaching preventive practice in learning environment as part of the meaningful learning which

utilizes insights from embodied cognition. The parts of the tables I created describe the most important background factors related to the prevention of musculoskeletal problems, and I would see that it is useful to divide the subject into parts to understand the whole. The table also presents various theories and concepts behind the practice that combines bodily cognition and teaching. I divided the table into the following areas based on section 1.2.1.1: 1) The Role of Movement and Ergonomics 2) Relaxation, 3) Aspects related to Cognitive Functioning 4) Psychological, Social and Sociocultural Factors 5) Growth and Development 6) Embodied and Enactive Methods and Preventive Programs. The table contains the risk factors and suggestions of the section 1.2.1.1 tables and the subjects from section 1.2.1.2 tables. Same line contains topics that could possibly be examined in the same context according to my evaluation. My goal is to present the topics of the preliminary review by evaluating them in the context of music pedagogy and backgrounding needs and orientation options for the future that have arisen through the processing of the subject group formed for the thesis that combines embodied cognition, musician's musculoskeletal problems and learning environment. As appeared through section 1.2.1.1 of the preliminary review about the musician's musculoskeletal problems, topics directly related to theory of embodied cognition didn't appear, but the topics were related to cognitive functioning in general. The actual search in section 2 aims to find research for the synthesis which combines prevention of musician's musculoskeletal problems as well as the embodied cognition.

A gap in the literature can also be found in the fact that prevention has received less attention than treatment and rehabilitation, especially in the studies related to teaching environment and in the fact that the theories created from concepts of prevention and embodied cognition have not met in scientific field. According to my assumption, teaching preventing musculoskeletal problems could benefit from the perspective of embodied cognition in preventive practice development, paying attention to the importance of movement and growth through embodied cognition. My estimation from preliminary review is that the development of practice may benefit from paying attention to cognitive, adaptive, sensorimotor, and environmental factors related to movement and growth, as well as multisensory and development, and how the consideration of the mentioned areas means in the planning of movement and motivation. In addition to that, it is possible to assess which tendencies of the embodied cognition theory are relevant for this entity, so that they can be tested. For example, what is the role of embodied music cognition in the whole. According to the preliminary review, the risk factors and proposals can be roughly divided into aspects related to movement and development. Based on the preliminary review, no sources directly related to the topic could be found, so the hypothesis has not been tested as such, and my goal

is to present how the topic has been treated or ignored so far. According to my figures, sections 1, 2, 3, and 6 can help to identify and evaluate the experientiality and significance of the movement, and sections 4 and 5 concern developmental aspects. Embodied cognition can help to understand aspects related to the role and development of movement through cognitive-sensorimotor development and function and the meaning of the environment. In practical work this whole can be evaluated with the help of various methods and exercises created based on embodied cognition.

| | *Risk factors and suggestions for musician's musculoskeletal problems (1.2.1.1)*<br><br>*(Russell and Benedetto, 2014; Lee et al., 2013; Foxman and Burger, 2006; Cruder et al., 2020; Rotter et al., 2020; Zara and Farewell, 1997)* | *Subjects of embodied cognition in learning environment (1.2.1.2)*<br><br>*(Sullivan, 2018; Shapiro and Stolz, 2018; Kosmas and Zaphiris, 2019; Schiavio and Schyff, 2018; Maes, 2016; Nadyrova, 2017)* |
|---|---|---|
| The Role of Movement and Ergonomics | *playing-related behaviors, physical health indicators, neutral posture, accumulation of physical and postural stress, strain, importance of strength, upper extremities, ergonomic optimization (optimal instrument condition, biomechanical training, sitting position, lightning, chinrest type, acoustic factors), awkward posture, too isotonic and isometric movements, too early and repeated use of a technique requiring relaxation and fluency, sudden increase of training time, ease, natural movement, elevated arm position, flexor muscle behavior, excessive incorrect repetition, postural stress* | *human-, and technologycentered methods, gestures and imitation, active object manipulation, dynamic depictive gestures, metaphoric gestures, kinesthetic learning, creativity, emergent timing* |
| Relaxation | *practice time, breaks (of 10 to 15 minutes should be taken every 30 to 60 minutes during practice), absolute rest, farming up, warm-up exercises, physical and musical exercises, abrupts increase in practice time, years experience extertion after 45 min without breaks* | *visual stimulation, thinking with gestures, creativity and embodied simulation* |
| Aspects related to Cognitive Functioning | *body awareness, attitude towards pain (Some musicians accept musculoskeletal pain as a normal and* | *motor involvement/grounding knowledge to motor experience,* |

| | | |
|---|---|---|
| | *necessary), understanding the use of force, metacognitive thinking, enjoyment of music, concept of balance* | *self-organization, motor simulation, exogenous embodiment* |
| Psychological, Social and Sociocultural Factors | *psychosocial stress, psychosocial factors, stress related to playing instrument, string class frequency, social factors, mental health indicators, high somatization, fear of a career-ending disability, temporomandibular disorder (TMD) related to musician's performance-anxiety (MPA), targeted interventions* | *collaboration, situated learning, situation-specific way of coping, improvisational and informal musical learning, expressivity and emotional component of music education* |
| Growth and Development | *cognitive development, the effects of growth on muscle development, women gender, (gender was not a significant (…) women gender was significant (…), subjective factors, age, disabilities, first- or second-year master's student, accumulative physical stress, grade (lower graders had more discomfort related to higher grades; …)* | *gestures, sensorimotor exploration, the Bayesian brain, prediction, error-correction and motor adaptation, role of long-term processes involving learning* |
| Embodied and Enactive Methods and Preventive Programs | *Feldenkrais Method, Alexander technique, prevention programs, prevention and treatment strategies, primary and secondary prevention, 'Groningen Exercise'* | *technology-centered methods (embodied interaction, virtual reality, videos, applications: tangibles, kinect/wii, embodied artifacts, biosensor, embodied games), interactive musical learning, enactive approaches (Dalcroze Eurhythmics, Orff Approach, Kodai, Cohen Body-Mind Centering)* |

Table 5 Embodied Cognition in Preventive Practice Development

The first section considering ergonomics and movement is broader in content than the other sections and the less considerations for the factors outside of physical functioning is noticeable. In the section ergonomics and the role of movement, I included topics from section 1.2.1.1 that considered ergonomics and movement through the factors related to playing-related behaviors, causes and consequences related to musculoskeletal problems, and factors preventing the occurrence of problems in playing practice. Teachers could benefit from multidisciplinary developed indicators of physical functioning, which could be used to understand the student's risk factors for developing

some kind of musculoskeletal problems or needs related to physical functioning and improve the possibilities of applying teaching utilizing the preventive and cognitive dimension more individually. Based on the preliminary review, the problems usually focus on the upper extremities, and the risk factors appearing in playing practice are accumulation of physical and postural stress, strain, awkward posture, postural stress, incorrect flexor muscle behavior, too isotonic and isometric movements, too early and repeated use of a technique requiring relaxation and fluency, sudden increase of training time, elevated arm position and excessive incorrect repetition. Preventive factors in playing practice are neutral posture, strength, ease, natural movement, and ergonomic optimization, considering, for example, optimal instrument condition, biomechanical training, sitting position, lightning, chinrest type and acoustic factors. I would see it meaningful to focus exercises on the mentioned risk factors with the help of preventive factors and evaluate them through the concepts emerged from embodied cognition.

According to the National Research Council (2001) biomechanics evaluates the movement of a living organism and the internal and external forces such as loads originating from the external environment and their effect on tissues and fluids. According to the article, work-related musculoskeletal disorders are caused by complex events and one model to explain this is the cumulative trauma model, where internal tolerances of tissues are exceeded through the accumulation of load caused by long-term exposure or repeated exposure. (National Research Council. 2001) A musician's work includes both a lot of repetition and long periods of exposure almost necessarily. Basic knowledge of biomechanics could be useful for teachers and work together with the studies and experiential knowledge from musician's studies. Biomechanical training could be a part of optimizing ergonomics, focusing for example on sitting position, lightning, and acoustic factors. According to Bagnara and Pozzi (2015) already considers cognitive and physical dimensions by dividing into cognitive and physical ergonomics. However, the explanatory level could take both into account at the same time, and these questions can be examined through the connection between the body and communication or linguistics. (Bagnara and Pozzi, 2015) Ergonomics could be approached through embodied cognition by trying to understand the role of movement, the effect of the state of mind on the body's functions and by considering how acoustic factors, like the individual sound of an instrument regarding to loudness or other factors affect and how acoustic factors could be approached overall.

In exercises supporting ergonomics and playing practice (neutral posture, strength, ease, natural movement, and ergonomic optimization), the cognitive dimension could be assessed, for example, with the help of embodied cognition practices from section

1.2.1.2, such as human-, and technology-centered methods, gestures and imitation, active object manipulation, dynamic descriptive gestures, metaphoric gestures, kinesthetic learning, creativity, and emergent timing. In my opinion, the embodiment in ergonomic learning environment could be approached with the help of human-centered methods. Human-centered methods include gestures and imitation, active object manipulation, motor involvement (Sullivan, 2018). Dynamic descriptive gestures refer to motion-based representation of a concept through multiple body states. (Khatin-Zadeh, Farsani, Eskandari, Marmolejo-Ramos, 2022) Dynamic gestures could be climbing, swimming, painting, porridge soup or similar mental images that combine movement to describe healthy movement. Dynamic gestures like this are popular in the Suzuki Method. Metaphorical gestures describe abstract concepts that have no spatial instantiation in the world using physical space (Casasanto and Lozano, 2007) For example metaphorical gestures as part of understanding the physiology of playing in the learning environment could be metaphors related to healthy physiology to dynamically describe a person as a physiological being that is affected by the environment in different ways.

Kinesthetic learning refers to physical interaction with the learning experience, and it utilizes the body, senses, kinetic perception, and sensorimotor experiences together. (Kosmas and Zaphiris, 2019) In this context, it could be useful to evaluate kinesthetic learning closer to with the concept of embodied learning, which consider more closely the connection of cognitive and sensorimotor activity to the environment and its significance to the factors affecting the body's physiology and physiological performance in the learning environment. Embodied learning is a broad concept, which is affected by different sub-areas. I also connected the concept of creativity to the first section, because I think it would be useful to examine the student's creative potential through health in the learning environment, considering external musical issues that also affect preventive playing, for example by considering the role of the body and the importance of exercise from the perspective of playing. According to Malinin (2019) embodied creativity is divided into two streams:" The first stream involves experimental examination of embodied metaphors associated with creative thinking. These studies typically assess effects on ideational productivity of enacting metaphors through specific bodily movements. For example, free walking might enact the embodied metaphor thinking outside of the box... The second stream examines creativity from a dynamical systems perspective as an emergent phenomenon that is distributed between people and artifacts of the material environment. For example, musical creativity is examined as a system of emergent, dynamic interactions among musicians and instruments" (Malinin, 2019).

Based on my vision related to analysis emergent timing concept considered in Maes study (2016), or more broadly timing strategies, which belongs to the trend of radical enactivism could be considered in connection with out-musical issues in relation to movement. According to study (2014) movement-based expertise using timing strategies like music or sports requires accurate knowledge of movement timing and the capacity to anticipate timing events based on, for example, to event-based or emergent timing. Emergent timing refers to controlling continuous movement which is emphasized in sports and event timing to discrete movements which is emphasized in music. According to study music training refines both discrete and continuous rhythmic movements. (Janzen, Thompson, Ammirante and Ranvaud, 2014). (Janzen, Thompson, Ammirante and Ranvaud, 2014) It can be significant to study the relative importance of timing in the development of preventive and motivating practice. For example, how timing strategies can be used to improve physical activity, motivation and understanding of musical movement. For example, what significance does different timing-based movement have for recovery or can learning timing strategies encourage movement and reduce the pressure of planning it. Also considering what is the importance of repetition in continuous unplanned movement or whether timing strategies can be used to help observe health indicators could be useful. Overall, the table is a sketch of the topics and possible connections while considering targeting developing exercises the role of movement and ergonomics is an area where the topics of embodied cognition mentioned in other parts are suitable to be considered as well.

Comprehensive relaxed embodiment is a condition that prevents musculoskeletal problems. Thinking through embodied cognition, relaxation should be approached through cognitive and sensorimotor activity and their relationship to the environment and development. According to section 1.2.1.1, factors related to warm-up and time use are relaxing preventive factors in the playing environment. These include, for example, breaks (of 10 to 15 minutes should be taken every 30 to 60 minutes during practice), meaning of absolute rest, farming up, warm-up exercises, physical and musical exercises, abrupts increase in practice time as well as years of experience of extertion after 45 min without breaks. I considered connecting visual stimulation, thinking with gestures, creativity, and embodied simulation with the relaxation-related subjects. According to Sullivan (2018) active learning requires visual stimulation. For example, the visual stimulation in education can refer to situation where the movement helps the student to focus his attention on the information being learned. (Sullivan, 2018) In the case of relaxation, visual stimulation could be realized through relaxing images, supporting the skills of emotional regulation, and the connection of this to relaxation could be possibly explored further. Visual stimulation can be used to stay in the right position or to find smaller movement trajectories, and it can also help with

relaxation with, for example, boards, learning cards or a video model. According to Song and others study (2018) forest images were found to cause "(1) a significant decrease in oxy-Hb concentrations in the right prefrontal cortex and (2) a significant increase in Perceptions of feeling "comfortable," "relaxed," and “natural.””. (Song, Ikei and Miyazaki, 2018) I see that the possibilities of the environment for achieving relaxing atmosphere should not be underestimated.

According to Gallese (2006) embodied simulation refers to a situation where, through the sensory description of a social stimulus, internal representations associated with actions, emotions, and sensations are evoked in the observer as if the observer were experiencing the same situation. (Gallese, 2006) I consider the relational system and expressive gestures mentioned by Nadyrova (2017) in understanding the construction of music using embodied simulation. In such a situation, the practice would focus on the relative elements of the music, combining expressive gestures and embodied simulation, and the approach to the relativity of music brings a relaxed atmosphere to learning. Learning by thinking with gestures was discussed by Shapiro and Stolz (2018) through examining the relationship between gesture and speech used by children and its effects on learning to think with gestures and teachers who display discordance benefit learners by exposing them to different strategies in gestural modality (Shapiro and Stolz, 2018). Gestures can contain information that a person does not necessarily know knowing and gestures can be used to guide thinking. According to my assumption, a student could also learn to recognize the need for relaxation through gesture knowledge, and the effectiveness of gesture knowledge in connection with relaxation could be empirically tested. Relaxation and creativity have been examined in several different studies in the same context. For example, according to study (2014) related to recovering in work the results suggest that creative activities help in recovery (Eschleman, Madsen, Alarcon and Barelka, 2014). In this context, creativity would be approached as a means of relaxation, considering cognitive and sensory motor function, development, and the concept of environment and creativity in its scope, in this context, deserves its own study and could lead to many interesting exercises to supporting frameworks.

In section 1.2.1.1, preventive suggestions referring to cognitive functioning were body awareness, understanding the use of the necessary force, developing metacognitive thinking, understanding the enjoyment of music and the concept of balance. Risk factors related to cognitive functioning were harmful attitude towards pain. According to Fisher, Chacon and Chaffee study (2019) cognitive functioning refers to different mental abilities including learning, thinking, reasoning, remembering, problem solving, decision making, and attention. (Fisher, Chacon and Chaffee, 2019). I evaluate the

mentioned concepts of the section 1.2.1.1 being related to cognitive functioning. I consider if the development of various cognitive skills could play a role in the prevention of musculoskeletal problems. According to my evaluation motor involvement (grounding knowledge to motor experience), self-organization, motor simulation and exogenous embodiment could be tools to consider in development of cognitive skills in the context. The study of Sullivan (2018) process gestures through explicit and implicit memory and elaborative memories and how gestures play a role in later structuring and recognition of the learned. According to Shapiro and Stolz (2018) physical experience enhances learning concepts, gestures contribute information, discordance refers to openness for learning and body being a supplement or substitute for knowledge and a tester of ideas (Shapiro and Stolz, 2018). Kosmas and Zaphiris (2019) discuss gestures by introducing how gestures attract attention in learners and stimulate thinking and how movements help to attract attention, encode information, and facilitate the communication and interaction between learner, technology, and environment. (Kosmas and Zaphiris, 2019)

Motor involvement or grounding knowledge to motor experience is processed in Sullivan's (2018) research in the context of combining mathematical concepts and physical movement. The article stated that understanding increased when motor involvement was added to the subject being learned. (Sullivan, 2018) I think this could be used to help understand the structure of music with different body movements, for example by moving to the music while focusing on balanced, healthy movement with small ranges of motion. In this way, body awareness, balance and increasing the understanding of the structure and content of the music would be combined, and this could reduce excessively isotonic and isometric movements during the performance. Sullivan (2018) describes self-organization as part of the learning process, where cognition is triggered by the environment and learners sustain themselves. (Sullivan, 2018) Through the understanding of adaptive behavior, teaching could develop new perspectives on practice that would consider the importance of self-constitution, self-coordination, and self-organization processes in playing practice that supports and develops health. In this context, it could be considered teaching to intuitively recognize one's own needs or correcting bad posture without having to consciously think about certain tasks. Teacher could consider teaching recognition of information that can be found already from the movement. Developing metacognition was a preventive factor in section 1.2.1.1. Metacognition is referred to, among other things, as follows: "... awareness of one's own thinking, awareness of the content of one's conception, as active monitoring of one's cognitive processes, an attempt to regulate one's cognitive processes in relationship to further learning..." (The Psychology Notes Headquarters, 2020) According to Skulmowski and Rey (2017) physical effort and cues also develop

metacognitive thinking (Skulmowski and Rey, 2017). This supports the idea that listening to the body's cues can be important in the development of preventive practice.

According to O'Shea and Moran (2017) motor simulation theory aims to explain how action-related cognitive states relate to actual motor execution states and examines the effects of imagining an action without executing the movements involved on learning. In the described situation, similar brain areas are activated, and the activity can be practiced in the mind via a putative simulation mechanism (O'Shea and Moran, 2017). According to Schiavio and Schyff (2018) exogenous embodiment refers to utilizing the environment in cognitive functions or things where the source is the environment, e.g. the teacher's gestures. Hybrid extended cognitive systems refers to the exogenous embodiment and tools for integrating the body to the environment or to the part of the cognitive strategy. Exogenous embodiment includes studies related to subjects such as teacher's gestures and imitation. Utilizing the hybrid cognitive systems enables exploring the 'hidden' relational aspects of the music and creating novel ways to express the practice starting with interactive, timbral and improvisational aspects. (Schiavio and Schyff, 2018) I think the area of the embodied language would also be useful to examine through relaxation, for example more specifically related to the use of metaphors or regarding the understanding of the use of force. It would be meaningful to find out in which ways the environment can be utilized in music learning as a supplement or substitute for cognitive functions or a tester of ideas.

The importance of psychosocial factors in the occurrence of musculoskeletal problems has been recognized in Finland in recent years. The Finnish Association of Music Medicine has considered the importance of psychosocial factors in the development of musician’s musculoskeletal problems by establishing a psychosocial division in 2021. According to the association, psychosocial factors play a significant role in the development of musculoskeletal problems, describing that somatic ailments often have a psychosocial dimension. (Smuly, 2021) According to the Finnish Institute of Occupational Health (2023), psychosocial factors can refer to excessive workload, conflicting demands, ethical burden, monotony of work, threat of violence. (ttl.fi, 10.4.2023) According to the announcement of the Finnish Occupational Safety and Health, the content of the work and the social functioning of the community related to psychosocial work load factors (Työsuojelu, 2023) The University of Turku's (2022) study mapping the effect of psychosocial factors in childhood on cognitive development in adulthood dealt with psychosocial factors such as the family's socioeconomic status, emotional atmosphere, stressful life events, parents' health behavior and the child's adaptability and self-control, of which the child's adaptability and self-control had the greatest impact on memory and learning in later life. (Raitakari, Rovio, Nurmi, 2022) According

to Räsänen and Sauvola (2023), somatic symptomatology is always a comprehensive experience that combines physiological phenomena, emotional reactions, cognitive perceptions of the symptom and the effects of all of these on behavior. (Räsänen and Sauvola, 2023) A music teacher regularly participates student's life, and awareness of the psychosocial dimensions and cognitive load factors related to playing an instrument or from broader perspective is useful from the perspectives of holistic support and prevention.

In the section 1.2.1.1 risk factors for musculoskeletal problems regarding to psychological, social, or sociocultural factors were psychosocial stress or stress directly related to playing instrument, string class frequency, different social factors, fear of a career-ending disability temporomandibular disorder (TMD) related to musician's performance-anxiety (MPA) and high somatization. According to Orthopedic and Spine Center (2023), stress can worsen the symptoms of many musculoskeletal diseases, for example by increasing pain sensitivity and worsening musculoskeletal symptoms and preventing recovery. (osc-ortho.com, 10.4.2023) Stress was also one of the risk factors in the table 1.2.1.1 mentioning that problems arise in techniques that require the most relaxation. (Russell and Benedetto, 2014) The problem could be due to the notion that these techniques are stiffening in a situation where holistic relaxation is especially important, and problems arise because of the bodily contradiction where a person tries to relax himself mechanically without a genuine experience of relaxation. I wonder if some exercises for embodied cognition could be used as an effort to resolve the contradiction and to consciously target the exercises when practicing challenging techniques. According to section 1.2.1.1, preventive measures were the identification of mental health indicators and targeted interventions. I wonder if embodied cognition could give a perspective of cognitive-sensorimotor development and function and the importance of the environment to social, socio-cultural and psychological factors in the learning environment, for example by evaluating the role of collaboration, situated learning, situation-specific way of coping, improvisational and informal musical learning, expressivity and emotional component of music education in the development of preventive practice related to this context.

In the article of Schiavio and Schyff (2018) empathic processes are explored first in terms of embodied affective interactivity that allows for shared understandings to develop between autonomous agents. The emotional components of interaction can be understood through affective interactivity with sensorimotor exploration, expressivity, motor adaptation, skilled coping, motor simulation (reproduction in movements and gestures) or relational system and expressive gestures. (Schiavio and Schyff, 2018) A conscious practice of skilled coping in a learning environment could support the

achievement of easier relaxation and flow and the combination of the two. According to a study (2021), in which the connection between the well-being of university researchers and flow state was investigated during the Coronavirus Diseases-19, it was found that there is a significant positive connection between subjective well-being and flow state. (Wu, Xie, Lai, Mao, and Harmat, 2021) I see it as meaningful to investigate in the teaching environment what kind of meaning teaching and achieving a flow state can bring to preventive teaching. The fun element of improvisational and imitative exercises can be in creating an relaxed and accepting atmosphere and the mentioned orientations could be built around warm-up exercises and an understanding of the body awareness around relaxation also in group lessons. Group lessons could focus on improvisation, where elaboration technique would be used with music. In individual interventions, elaboration through discussion could be part of the joint search for solutions. The development of prevention from the point of view of collaboration and interaction could also be related to, for example, the development of a group program where attention is focused on healthy movement or performance anxiety and the practice could be built around synchrony and affective interactivity between the group and this could be a kind of targeted intervention through teaching.

In the section 1.2.1.1 risk factors for musculoskeletal problems regarding to growth and development were women gender possibly, subjective factors, age, disabilities, first- or second-year master's student, accumulative physical stress, grade (lower graders had more discomfort related to higher grades). In prevention, factors related to cognitive development and the effects of growth on muscle development must be considered and in general identify things that affect development and growth in a way of developing musculoskeletal disorders. I wonder whether this point of view could be addressed through the theory of embodied cognition, for example discordance and concordance, gestures, sensorimotor exploration, the Bayesian brain and Prediction models, error-correction and motor adaptation and the role of long-term processes involving learning and prediction. According to the Shapiro and Stolz study (2018), discordance and concordance were processed by assessing the student's level of understanding and readiness to learn. Discordance, which refers to a mismatch between speech and gesture, was a sign of readiness to learn new things (Shapiro and Stolz, 2018). The use of gestures, for example descriptive or metaphorical gestures, could be considered especially in relation to things affecting development and growth. According to Schiavio and Schyff (2018), sensorimotor exploration refers to a mechanism in learning that has been shown to be primary for humans. According to the research, the focus on interactive, improvisational, and informal kinds of musical learning has grown among scholars in educational sciences, and in these ways of learning music, sensorimotor exploration and other forms of bodily engagement are

emphasized. (Schiavio and Schyff, 2018) The teacher's creativity is the limit of what can be invented by considering the sensorimotor engagement and self-producing activity perspective and it could be used by considering long-term development and growth.

Factors related to growth and development include, for example, factors related to cognitive development as well as identifying and considering muscle growth stages from a long-term perspective in teaching. Educational implications emerged from neurobiology research are diverse and they can be used to understand the stages of the learning process and the above-mentioned possible subjective risk factors such as disabilities or causes in the background of accumulative physical stress. The Bayesian brain hypothesis discussed by Maes (2016) is based on the "radical" embodiment thesis where music perception is a dynamic process rooted in the natural disposition of sounds and the human auditory and motor system. The perception dominates the field of psychology and neuroscience in explaining brain's functions like sensory perception or high-level cognition. (Maes, 2016) According to Gopnik and Tenenbaum (2007) processing children's causal learning, they solve problems related to inductive inference routinely and effortlessly. (Gopnik and Tenenbaum, 2007) According to study (2020) the results show a predictive connection between multi-sensory benefits in simple detection and higher-level cognition in schoolchildren. The study shows that childhood low-level multisensory processes predict higher-order memory and cognition. (Denervaud, Gentaz, Matusz and Murray, 2020) From the healthy cognitive development view, multisensory aspects in learning are useful and different explanatory models behind the learning of abilities can help to understand learning in a more age-specific way and to utilize abilities that are suitable for behavior and abilities that are natural, enabling combining preventive teaching and age-specific abilities. The music learning environment is multisensory in nature, and for this reason it can be useful to also understand the importance of the nature of the learning environment for development and growth.

Perspectives related to development and growth in the development of preventive education could focus on generalizable and individual perspectives. The importance of muscle growth stages in the development of musculoskeletal problems could be considered. The study (1995) describes muscle growth in young people as follows: "Periods of arm muscles growth are 12 and 15 years and that is 13 and 15 years for leg muscles. Most significant growth speed for both groups fall on the age of 15. By 16 years growth speed reduces both for body and limb muscles weight. However, by 17 years growth speed increase for body weight and leg muscles only." (Tambovtseva, 1995) The above study reflects the non-linear nature of development. My assumption

is that incorrect positions and incorrect playing technique are particularly harmful in phases where the growth of muscles and height is rapid, and in teaching, special attention could be paid to these phases. In the case of young children, in the early stages of their playing practice, attention could be paid to taking the children's age-specific gross motor skills into account. According to Foxman and Burger (2006); "Primary prevention of playing-related musculoskeletal disorders, through identification of intrinsic and extrinsic risk factors, should be initiated at the beginning of music education. "(Foxman & Burger, 2006) Perhaps using motor simulation for young people could be an option to reduce extra strain. For example, The Suzuki Method utilizes different types of gross-motor skills combined with musical movement and imagery and according to my notion the method resembles the emphases of the embodied cognition theory supports motor development.

The sixth section is related to embodied or Enactive teaching methods and preventive programs. According to section 1.2.1.1 Feldenkrais Method, Alexander technique is used in preventive teaching. According to review (2015) Feldenkrais Method focuses on learning how to learn through improving awareness, health and ease of function guided through a series of movement and sensation-based explorations individually or in a group. The review provides evidence of the benefits of the method as a preventive approach and in reducing pain or discomfort. (Hillier and Worley, 2015) Alexander technique is a posture-modifying method, like Feldenkrais focusing on kinesthetic re-education and the process is called constructive conscious control (Foxman and Burgel, 2006) In addition to the mentioned, individual preventive programs and strategies have been developed in different settings concerning primary and secondary prevention. One of the mentioned targeted programs was the Groningen exercise. According to study of Groningen Exercise Therapy for Symphony Orchestra Musicians (GETSOM) program (2003), which emphasizes relaxation, postural exercises for the shoulder, neck, and lower back considering physical workload and mental stress was shown to be efficacious in decreasing playing- related musculoskeletal diseases. (Greef, Wijck, Reynders, Toussaint and Hesseling, 2003) Developing similar targeted programs and measuring their effectiveness could be considered at an earlier stage, targeting, for example, music students. The perspective of embodied cognition related to different programs and strategies includes, for example, to technology-centered methods and interactive musical learning applications or different enactive approaches like Dalcroze Eurhythmics, Orff Approach and Cohen Body-Mind Centering.

Dalcroze Eurhythmics focuses on developing an understanding of the essence of music through exercise, singing, tuning and improvisation. (Juntunen, 2019) Orff Approach also includes improvisation and different ways of participating in making

music by singing, playing, dancing, or speaking by developing a person's natural musicality. The approach emphasizes the connection of language, music and listening (Blair and McCord, 2015) Cohen Body-Mind Centering embodied application using anatomical, physiological, psychophysical principles utilizing movement, touch, voice, and consciousness. It is applied in many fields such as physical and occupational therapy, psychotherapy, child development, education, music, art, meditation, dance, yoga, bodywork athletics and other body-mind disciplines. (bonniebainbridgecohen.com, 2024) According to my notion possibilities of technology for music education can be examined for example in the sudden situations of the need for distance teaching, and in educational research exploiting different embodied interaction with virtual reality, videos, or applications. (Sullivan, 2018) These different programs that consider cognitive-sensorimotor development and functioning and the importance of the environment could be considered from the perspective of developing preventive education. Based on this preliminary review, there can be many different perspectives related to practice. I think it is meaningful to look at how the field of health and well-being has considered the areas emerged from embodied cognition or embodied music cognition. The enactment perspective presented in the introduction could consider the biomechanical effects of the body's effectors and their role in future brains or other health. Entrainment could take the perspective of how the activating effect of music can help to use the body preventively. Gestures research can focus on including cognitive elements and considering information processing related to the environment and studying its role in maintaining health. It could be meaningful to examine how exploring and modifying the environment can be included in preventive practice.

### 1.2.2 Research Questions and Objectives

The objective of the thesis is to synthesize literature related to embodied cognition in the learning environment and prevention of musician’s musculoskeletal problems and to explore the perspectives for preventing musician’s musculoskeletal problems in the learning environment from that point of view. My assumptions are that the consideration of the sensorimotor and cognitive functions is essential in the development of preventive practices and that learning musical instrument could be seen supporting psychophysical development holistically and preventing injuries as much as doing sports are seen to accomplish. The hypothesis of the thesis is that the embodied cognition considering sensorimotor and cognitive factors and the self-organizing nature of them in the learning environment, can be a worthwhile tool developing the

prevention of musician's musculoskeletal problems and increase societal appreciation towards learning music and on how we perceive the meaning of movement essentially.

# 2 METHODS

This section contains the description of progress of the analysis including search strategy 2.1, eligibility criteria, 2.1.1, screening and selecting 2.1.1.1, critical appraisal 2.1.1.2, data extraction and analysis 2.2. The thesis is conducted as a mixed method integrative literature review design analyzed and synthesized with thematic, constant comparative and content analysis as the critical interpretive approach including narrative summary suitable for mixed method research synthesis.

## 2.1 Search Strategy

The data search was conducted 11.10.2023 using five databases including computer-assisted databases and gray literature including Web Search Engine Google Scholar and manual search. Databases included Scopus, PubMed (Medline), ERIC, Web of Science, DOAJ. The inclusion criteria for the initial search were English as the publication language. The publication date in DOAJ were between the years of 2014-2024 and in other sources between the years of 2018-2024.

| data sources | publication date | search terms / document type / subject area |
|---|---|---|
| Scopus | 2018-2024 | (prevent* OR musculoskeletal* OR playing*) AND ("embodied cognition" OR "embodied music cognition") AND ("teaching" OR "learning") AND ("music")<br><br>document type:<br>limited to article, book chapter, review, and conference review<br><br>subject area:<br>Arts and humanities, multidisciplinary |
| PubMed (Medline) | 2018-2024 | (prevent* OR musculoskeletal* OR playing*) AND ("embodied cognition" OR "embodied music cognition") AND ("teaching" OR "learning") AND ("music") |
| ERIC | 2018-2024 | (prevent* OR musculoskeletal* OR playing*) AND ("embodied cognition" OR "embodied music cognition") AND ("teaching" OR "learning") AND ("music") |
| Web of Science | 2018-2024 | (prevent* OR musculoskeletal* OR playing*) AND ("embodied cognition" OR "embodied music cognition") AND ("teaching" OR "learning") AND ("music") |
| Google Scholar | 2018-2024 | embodied cognition, learning, teaching, music, prevention, playing-related*, musculoskeletal* |
| manual search | 2018-2024 | prevention of musician's musculoskeletal problems and embodied cognition |
| DOAJ | 2014-2024 | 'embodied music cognition* OR embodied cognition' AND 'musculoskeletal* OR playing-related*'<br><br>Selected subjects: music and music books |

Table 6 Data sources

Based on the preliminary review, the subject area formulated for the thesis and synthesis was somewhat unknown. Therefore, the purpose was to conduct the wide as possible data search within the scope of the set schedule and within the limits of a single review with the aim of finding research sidestepping or processing the formulated objectives in the manner discussed within the scope of the topic or in a specific way, from which a general understanding describing the practice and the state of the topic could be formed. The goal for the initial search was to find research content combining the learning environment, the prevention of musculoskeletal problems, and music as a topic. I conducted some testing with different search terms and ended up to recorded terms above as the ones that could best answer my research questions. In relation to musician's musculoskeletal problems, the limitation to search term playing* in search can give answers related to playing- related musculoskeletal symptoms, -problems, - disability, -injuries or other terms referring to changes in health and divide the search into musicians. Limitation to search term musculoskeletal* can also refer similarly to terms referring to various musculoskeletal problems. I noticed that often the musculoskeletal problems of musicians are referred to in the text with phrases that start with the mentioned terms. The eligibility criteria (2.1.1) contain descriptions and justifications for the inclusion criteria for the initial phase of the thesis, as well as the inclusion and exclusion criteria for the screening phase. In the screening and selecting phase (2.1.1.1), I describe the flow of the information search using the PRISMA flow diagram and describe, justify, and evaluate the inclusion criteria for the screening and full-text phase.

The References of the studies identified were imported to Zotero and uploaded into Covidence for review. According to Zotero Website (2024) Zotero is a citation management software for managing research materials and bibliographic data. It was created for the Center for History and New Media at George Mason University and since 2021 developed by the non-profit Corporation for Digital Scholarship. (Zotero, 2024) I didn't use all the potential that Zotero offers, but it helped me read the articles. According to Covidence Website (2024) Covidence is a tool for conducting systematic reviews assisting in screening and data extraction process. (Covidence, 2024) I used the free version of Covidence, which helped to organize the data in the initial phase of the PRISMA table, removing duplicates and clarifying the progression of the screening phase. According to Toronto and Remington (2020) PRISMA is used in integrative and systematic reviews. The PRISMA guideline was developed to increase quality and transparency in reporting of the systematic review and minimizing bias in the reporting and to facilitate time management and search reporting. The abbreviation consists of the words Preferred Reporting Items for Systematic Reviews and Meta-Analyses (Toronto and Remington, 2020). According to Toronto and Remington (2020)

sometimes the volume and quality of published literature are insufficient to address the review question, then gray literature may provide a rich source of data and context to the review (Toronto and Remington, 2020) In the case of my thesis, I justify the need to include gray literature with the small amount.

I used the CASP (Critical Appraisal Skills Program) checklist to help planning the assessment. According to CASP (Critical Appraisal Skills Program) Webpage (2024) the CASP is used in healthcare research for the critical evaluation of research and the trustworthiness, relevance, and results of published papers. (CASP, 2024) I did not go through the entire checklist for all studies, because I do not see mutual comparison and scoring adding value to thesis more than a shorter assessment of the possibilities of the content, since the number of included studies is small and without clinical practice future implications. It is also difficult to make a comparison between the reliability of the texts because the studies concern different methods, results and even topics on purpose. Eight from eleven included articles were peer-reviewed. I chose the rest because they considered perspectives important to the subject, which were not encountered among the peer-reviewed articles processing the development of research, the importance of language and healthy interpretation. I appraised the studies by supplying a short assessment of the possibilities in relation to the question of whether embodied cognition is a worthwhile basis for development of preventive pedagogical practice in music learning environment and the significance of my thesis in terms of the overall picture of the subject, as well as limitations in relation to the interpretation of the results of the thesis. The limitation of conducting the search is that embodied cognition is a comprehensive umbrella term for extensive scientific research, which can direct the search to research being far from the topic of the thesis. In turn my purpose is to get a broad picture of the literature considering my topic, but the mentioned limitation can affect the reliability of the overall picture created from the results.

The free trial of qualitative data analysis software NVivo was used for searching and outlining the basis for the search themes and recurring concepts in the included studies. NVivo has been developed to help with the organization and in-depth analysis of unstructured qualitative data. (McNiff, 2023) Data extraction stage consisted of extracting the content from the included studies. The included studies clearly formed two categories, where the studies of the first category considered the prevention of musician's musculoskeletal problems in musicians, learning and music pedagogy, including an emphasis on cognitive aspects. In the second category, the perspective referring to health, learning and music pedagogy was emphasized, including an emphasis on theory of embodied cognition. The reason for the two categories is the object of understanding what the categories can give each other in terms of healthier music

environment and also the fact that when combining the sources, embodied cognition, prevention and music environment were not found. More precisely, the goal was to understand whether the data considered the theory of embodied cognition can bring a deeper perspective to the prevention of musculoskeletal problems in musicians in the field of music pedagogy or, more broadly, to a healthy playing environment, or whether there are connections to the theory of embodied cognition in the content of the sources processing prevention, which could strengthen the metalevel emphasis of embodied cognition in the studies combining cognition and prevention. It can be valuable to recognize the variability of the concepts and to recognize the extent of the treatment of the subject at the meta-level, so that fresh ideas can be integrated to be more easily utilized in practice and research combining health and music.

The subject areas of the categories are divided into four codes connecting both categories, which are perspective or prevention, embodied cognition or relations to cognitive aspects, pedagogy and learning. Synthesis methods were content, thematic content and constant comparative analysis. In the synthesis, I examined the connections between the two categories by comparing them, and in addition compiled the results of the thematic and content analysis and created a narrative summary of the results. Based on the preliminary review, data extraction, and content analysis, the synthesis was divided into two high-level themes in which the first theme emphasizes behavioral control processes in relation to cognitive strategies and functions, including the role of senses and internal representations, as well as concepts of being, knowing and embodiment. The second theme processed the importance of information arriving from outside of the body and environmental factors in cognitive strategies and teaching. The reference framework for the synthesis formed from the two themes, which I think contains application possibilities, clarifying a wide subject area. The themes help to examine the subject from the perspectives of the teacher and the student, as well as conscious control and unconscious activity in relation to the environment and interaction during learning. During the discussion section, I examine the mentioned perspectives, especially from the perspective of preventive pedagogy and learning, and outline what it may contain based on an integrative review and my assessment. Discussion goes through how the topic appears even more precisely in preventive pedagogy in the frameworks of the synthesis and preliminary review, so that the evaluation of the development of the topic becomes possible and possibility for evaluating what bringing together the results of the preliminary review and the actual search gives to the topic.

### 2.1.1 Eligibility Criteria

I selected English as the publication language for the initial search, because the language of my thesis is in English. A search combining Finnish and English would have been challenging to implement, even though finding research on the subject in Finnish would also be valuable. During the application period, I noticed that the research-related concepts and their translations of some studies considering embodied research seemed to be in the development stage. The reason for setting the publication date to recent years is that, based on the preliminary review, none or presumably only recent research is found on the subject. My goal was to include databases containing multidisciplinary studies, music studies and health-oriented studies, and therefore databases included Scopus, PubMed (Medline), ERIC, Web of Science, DOAJ, Web Search Engine Google Scholar and manual search. In Scopus the used document type was limited to article, book chapter, review, and conference review. The subject area Scopus was Arts and humanities and multidisciplinary. Selected subjects in DOAJ were music and music books. The reasons for the limitations were the large amount of the data in those databases and the need to limit the topic to studies considering music as the part of the research content. In other data sources, it was possible to process the amount of data to be evaluated, the intended content remained somewhat within the topic, and therefore no additional restrictions were needed.

Scopus is database of peer-reviewed literature and includes research in the fields of science, technology, medicine, social sciences as well as arts and humanities. (Scopus, 2022) According to Lindsey and Olin (2013) PubMed is a database for Biomedical and life sciences literature maintained by the National Center for Biotechnology Information (NCBI). (Lindsey and Olin, 2013) PubMed (Medline) is limited to articles indexed with MeSHe (Medical Subject Headings) and curated with funding, genetic, chemical and other metadata (PubMed, 2023) ERIC, or Education Resources Information Center, is a digital online library and full-text database related to educational research and is sponsored by the Institute of Education Sciences of the US Department of Education. (ERIC, 2014) According to Birkle (2020) Web of Science (WoS) is the world's oldest and most widely used research database, covering multidisciplinary and field-specific information in different forms and it is currently maintained by Clarivate Analytics. (Birkle, 2020) The Directory of Open Access Journals (DOAJ) is a website that contains a large number of research journals and is maintained by Infrastructure Services for Open Access. (Morrison, 2017) The databases are deliberately emphasized in different ways to the health-oriented information, research with an

emphasis on arts and humanities as well as education and to widely used database considering many fields. I chose DOAJ, Google Scholar and manual search on the assumption that I would possibly find scientific literature other than scientific articles related to the topic and possibly new perspectives to in accordance with the integrative review methodology which emphasizes a broad perspective and an overview of the state of the subject.

| Eligibility criteria | |
|---|---|
| Inclusion criteria (initial search) | publication language: English<br>publication date: 2014-2024 (DOAJ),<br>2018-2024 (Scopus, PubMed (Medline), ERIC, Web of Science, Google Scholar) |
| Inclusion criteria (screening) | all studies including two out of the three:<br>1) music<br>2) embodied cognition and learning<br>3) prevention of musician's musculoskeletal problems |
| Exclusion criteria (screening) | clinical studies, rehabilitation studies, off topic, not suitable for wide perspective, game studies, machine learning, computer science, digital space, dramatic literature, Spanish or Slovenian as the publication language, music analysis, talent research, only processing music as the subject, ethnographic studies, social and societal studies, only processing perception as the subject, excessive specificity, wrong object/subject, wrong design, some dissertations (wrong design), books |

Table 7 Eligibility Criteria

The inclusion criteria of the screening phase were to include all studies considering two of the following three topics: 1) music, 2) embodied cognition and learning, 3) prevention of musician's musculoskeletal problems. Based on the preliminary review, it seemed that no sources could be found that would combine all three of the mentioned themes, and there is a gap in the literature regarding to that, and for that reason I took as a criterion that the studies would combine at least two of the three themes. According to Toronto and Remington (2020) the inclusion and exclusion criteria should identify whether inferior studies will be included or excluded after the appraisal process. Some suggest that all studies should be considered in the review,

despite low-quality ratings to allow for more diversity among the sample, whereas others suggest that synthesizing studies of high quality with those of lesser quality may lead to inaccurate conclusions (Toronto and Remington, 2020). In the case of my thesis and due to the elusive nature of the topic, I emphasized the topic more than the level of scientific writing in the screening. I ended up including eleven studies including three dissertations. Described in more detail, in the screening phase I automatically included studies considering prevention and musicians, as well as studies combining movement, learning and music in one way or another. I excluded 44 out of 136 studies in the screening phase.

I excluded studies that focused on clinical studies, rehabilitation studies, game studies, machine learning, computer science, digital space, dramatic literature, Spanish or Slovenian as the publication language, music analysis, talent research, ethnographic studies as well as social and societal studies. In addition to those mentioned, I excluded studies that focused only on music or perception or otherwise contained excessive specificity not suitable for formulating as wide perspective. An exception to the subject of music analysis is the one study in which the grounds for inclusion are found and assessed. In addition, I excluded studies, books, and studies with the wrong object, design, or subject. A large part of the subsidies excluded in the screening phase were studies based on clinical treatment. Excessive specificity is part of an exclusion criterion because I am aware that using only an umbrella term distorts the results, so the focus must be on achieving a superficial overall picture and thus also the sources must have as broad perspective as possible. There is also a possibility that sources could be found if it were possible to find out the terms that are most found under the shadow term embodied cognition related to studies dealing with prevention and musicians. This thesis, with its broad perspective, aims to find out the overall picture and what aspects relates to it.

#### 2.1.1.1 Screening and Selecting Process

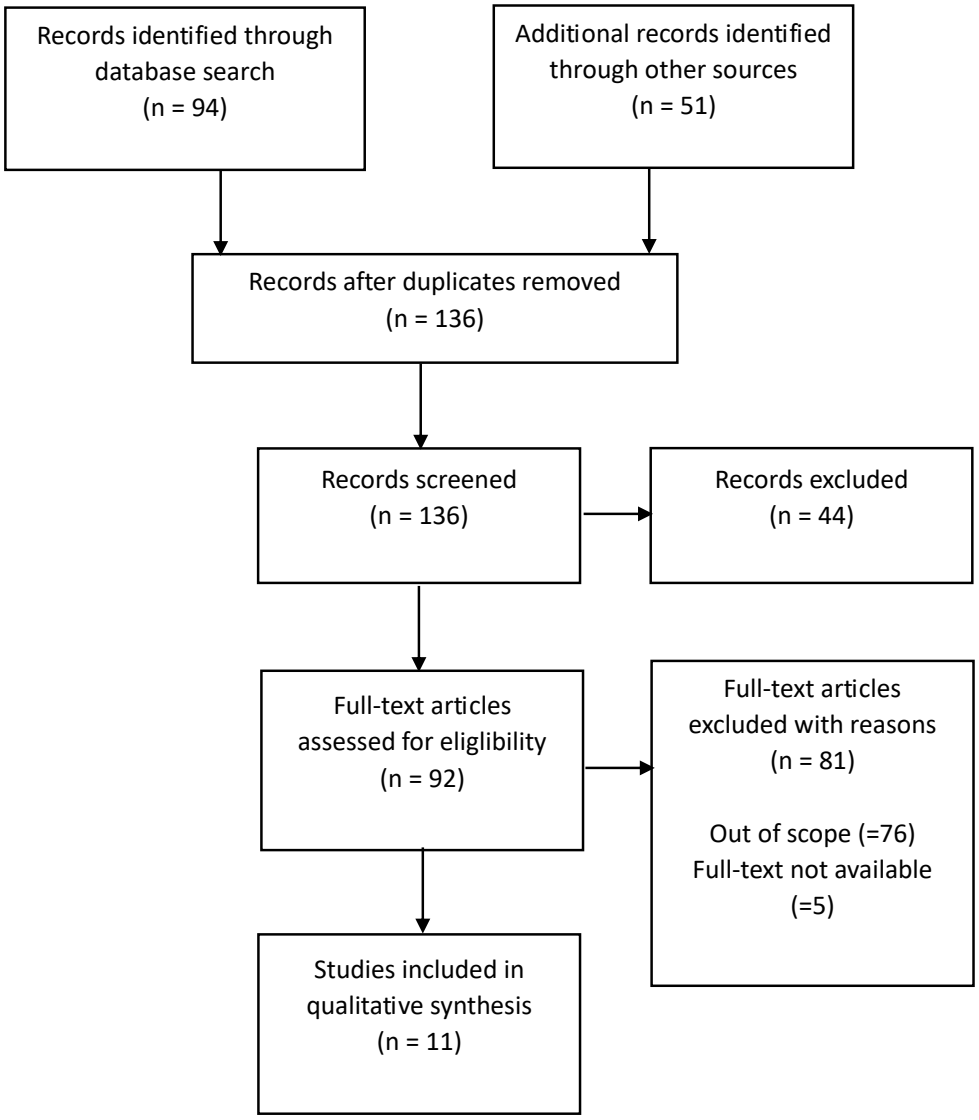


Figure 1 PRISMA chart

During the stage of full-text appraisal, the existence and scope of teaching methods considering cognition as a main theme came to notice. At the same stage it became apparent that the research articles or dissertations considering teaching methods and cognition were closer to the thesis subject than articles considering other subjects. These articles combined the learning environment, healthy or preventive playing and cognition without considering theory of embodied cognition. Decision to include articles considering music related methods was justifiable even though the methods were not directly related to the embodied cognition theory. Through including them

it could be possible to observe the overall phenomenon and connections between the subjects matters. The view of practical applicability of the content, different teaching methods related to music and diversity of research methods and types were evaluated in the full text appraisal. The full text criteria were the estimated applicability regarding subject of the thesis and the possibility of getting an overall picture of the subjects and trends related to it. The goal was a diverse picture of methods and research styles, and due to the fragmented nature of the topic, I included a small number of dissertations. Inclusion criteria for dissertations were the freshness of the topic and the effort to understand the practice closely and the detection of intersections between practical and scientific work. The research style that combines scientific and practical knowledge is methodologically suitable for integrative reviews. The fact that the dissertations among the articles in the full-text phase contained more of the desired information in relation to other scientific articles can indicate the subject being fresh for the moment or it being difficult to conduct empirical research related to the subject.

The number of excluded texts in the full-text phase was 81. At this stage, I still found some texts that were not suitable for my topic, the content of which was not clear in the screening stage, and some of the screening stage's exclusion criteria were also in use at this stage. Most of the excluded studies were studies based on clinical care or rehabilitation. At this stage, I excluded more studies whose topics only concerned music analysis or digital space and all books. I also excluded research articles that had the wrong design, subject, topic or where the full text was not available. As an exception for clinical studies, I included Détári's study (2023) because the article had the holistic disruption-oriented approach with the discussion of prevention and learning on a practical level. (Détári, 2023) The References of the studies identified were imported to Zotero and uploaded into Covidence for review. I used Zotero to outline the subject areas and made the free version of Covidence to help in the screening phase and to create the PRISMA chart. The free version of Covidence enabled initial screening and the creation of a PRISMA chart. In the full-text phase, I found some similar studies, but I wanted to limit the final analysis to 11 sources, which form a versatile overall picture of the subject within the framework of the single review, with the possibility to manage the subject more profoundly. During the screening and selecting process, it was difficult to find studies regarding to my research questions, let alone a broader perspective regarding the inclusion criteria of the screening phase.

I included 11 studies, of which 8 are research articles and 3 are dissertations. In the methods of the included studies, emphasis was placed on mixed-method and experimental designs and versatile research methods and techniques. The methods and research techniques included surveys, specifically designed curricula and interventions,

movement-based analyses, qualitative content analysis, interviews, methodological and theoretical frameworks, motion capture, instructional animations, and observational analysis. Experimental design included in the articles of Davies (2020), Détári and Nilssen (2022), Rader (2023), Massie-Laberge (2019), Mierowsky, Marcus, Ayres (2020), and Stevanovic (2021). Articles of Détári and Nilssen (2022) as well as Rader (2023) were intervention- based. Articles of Kongpakpaisarn (2020) and Papazachariou-Christoforou (2022) considered practical applications, with a particular emphasis on movement-based analysis. In terms of methods, Van der Schyff, Schiavio, Elliott (2023) including critical discussion, Détári (2023) processing practitioners' knowledge and Sabo, Comeau, Guptill, Dvorkin and Russell (2023) processing methodological framework stood out individually from included articles. The reason why the number of these methods is highlighted in the included sources is due to the goals of this thesis, which are aimed at understanding the overall picture, also from the viewpoints of the teacher's work and practice, and in experimental studies these seem to be highlighted. In addition to that, it may be possible that in the subject area, which is fragmented including recent theory, experimental studies may be highlighted as a trend when the theory or its parts are tested in different ways.

| | *Studies included for qualitative synthesis* |
|---|---|
| Research article (8) | *(Davies, 2020):* designed AT-classes and questionnaire<br>*(Détári, Nilssen, 2022):* Timani- intervention and mixed-methodology design<br>*(Sabo, Comeau, Guptill, Dvorkin, Russell, 2023):* methodological framework through qualitative content analysis and analysis of "biomechanical language"<br>*(Détári, 2023):* interview<br>*(Van der Schyff, Schiavio, Elliott, 2023):* critical ontology<br>*(Mierowsky, Marcus, Ayres, 2020):* observational design and questionnaire<br>*(Stevanovic, 2021):* conversation analysis from video recordings<br>*(Papazachariou-Christoforou, 2022):* practical considerations and discussion |
| Dissertation (3) | *(Kongpakpaisarn, 2020):* music analysis and video observation<br>*(Rader, 2023):* quasi-experimental design<br>*(Massie-Laberge, 2019):* exploratory study and experimental design |
| (=11) | (=11) |

Table 8 Included Studies

The 11 sources selected for their content focuses on the processing of cognitive function and factors in the context of musical environment. The sources combine either cognition, musical environment and prevention or embodied cognition and musical

learning environment from angles that are especially interesting for the thesis. In the mentioned contexts, the studies considered somatic method (5), symptom-specific clinical treatment and prevention (1), movement-based analysis (1), observational analysis (1), embodied cognition ontology (1), embodied cognition and cognitive load theory (1) and Cognitive linguistics (1). The sources can provide a comprehensive overview of cognitive activity in a musical learning environment. This basis can help to understand the prevention of future problems more holistically or the possibilities of cognition around prevention and teaching. None of those processing teaching methods considered embodied cognition theoretically, but cognitive elements in another way. Eight of the eleven articles were peer-reviewed. Five of the ones connecting cognition, prevention and teaching were related to some somatic method, which is interesting in itself from the point of view of the overall picture, describing the fact that it seems that cognition in relation to my thesis topic has so far been considered mainly within the framework of the somatic methods. The final results highlighted various pedagogical practical applications and discussions with the goal of reforming teaching, taking into account cognitive elements, in a way that benefits the well-being of teachers and students.

It is interesting that two of the five studies considering the somatic method were dissertations. Emphasis on the topic in dissertations may be due to the fact that there is not much other research on the topic so far, and in addition, practice may be emphasized in a more in-depth manner in dissertations. The two articles concerning somatic methods as Konpakpaisarn (2020) and Sabo, Comeau, Guptill, Dvorkin and Russell (2023), were instrument-specific and both processing the Taubmann approach. About the instrument-specific articles, all focused on piano playing and these were articles by Konpakpaisarn (2020), Sabo, Comeau, Guptill, Dvorkin and Russell (2023), Massie-Laberge (2019) as well as Mierowsky, Marcus and Ayres (2020). The articles by Massie-Laberge (2019) and Konpakpaisarn (2020) are different from the others, and they combine the musical interpretation dimension with health or healthy interpretation. It is interesting that the piano was emphasized in the articles more than other instruments, and there may be a need for a broader treatment of the subject. Articles considering several instruments were articles from Davies (2020), Détári and Nilssen, (2022), Rader (2023), Détári (2023), Stevanovic (2021). Processing the topic with an individual perspective, Van der Schyff, Schiavio, Elliott (2023) concerning music teacher education and Papazachariou-Christoforou (2022) concerning pre-school music classes differed. Embodied cognition is clearly discussed in 5 articles, where gestures, language, ontology, and movement analysis were emphasized. All the articles are united, and they emphasize interdisciplinary research and its need in the future implications.

#### 2.1.1.2 Critical Appraisal

In the studies of Davies (2020), Kongpakpaisarn (2020), Détári and Nilssen (2022), Rader (2023), Sabo, Comeau, Guptill, Dvorkin and Russell (2023) and Détári (2023) combination of the main themes of the thesis as music and prevention of musculoskeletal problems and cognition occurred without the theory of embodied cognition as a basis and related to that reason form a sort of research category. The value of the Davies study (2020) from the point of view of the thesis is in understanding the practical application of an already existing preventive teaching method and how the processing cognition and its importance can be seen in the application of the method and how it is connected to the theory of embodied cognition theory. The interest about the Alexander technique is the focus, in addition to violin technical issues, on the importance of the balance of the body's functions. The strength of the research is in targeting the method to certain tension problems and the demonstration of playing-related and non-playing-related pain. The weakness is the general problems of non-blinded survey studies, where respondents' answers can be biased. (Davies, 2020) In the Kongpakpaisarn study (2020) the confluence of music analysis and the somatic method according to the theory of embodied cognition is interesting. The thesis helps to understand more closely the embodied factors occurring in music and the holistic nature of combining health and playing practice. (Kongpakpaisarn, 2020) Assignment in theses usually requires using articles from peer-reviewed journals and dissertations are not part of them. However, I evaluated the practical perspective of my thesis being as relevant reason including some dissertations as well. It is meaningful to get an understanding of the topic from the different investigative dimensions of the whole picture related to the topic. Détári and Nilssen's study (2022) is included because the Timani method they discuss is very recent and the study also contains a recent understanding of exploratory research combining cognition, teaching, and music. (Détári and Nilssen, 2022) The limitation of the work as stated in the study, considering the perspective of the thesis, is that when processing the results, the risk of bias related to self-reports must be considered. I think the discussion in the study regarding implications was comprehensive.

The dissertation of Rader (2023) is included because it discusses how preventive pedagogy can be understood and incorporated especially from the beginning of musical study and is therefore closely related to the topic of my thesis. (Rader, 2023) This study has the same criteria for inclusion and limitations as other dissertations. Study (2023) processes transferring pedagogical knowledge into scientific knowledge by

transforming the pedagogical language of Taubmann approach to the biomechanical language. The strength of the study can be seen as the first inquiry produced in the way presented in the research, which can help transforming pedagogical knowledge more reliably in the future. Weaknesses include factors related to the individual interpretation of pedagogical language, which can bring limitations. However, a wide range of perspectives is a strength. (Sabo, Comeau, Guptill, Dvorkin, Russell, 2023) It is interesting in the work in which ways prevention has been tried to be developed based on the promotion of scientific knowledge and the facilitation of interdisciplinary research, especially because my own perspective focuses on converting scientific knowledge into pedagogical knowledge. I see it as useful to understand the transformation of pedagogical knowledge into the benefit of science to understand the transformation of scientific knowledge into pedagogical knowledge. Détári's study (2023) is the last study of the first category, and it is particularly interesting how aspects of cognition have been studied from a disorder-oriented perspective. The focus of the research is on treatment and rehabilitation but consider prevention from a holistic perspective. (Détári, 2023) Trying to understand a holistic perspective on prevention is also the goal of my thesis. Research can open connections related to treatment and prevention and the psychophysical background of disease development and symptoms by examining the influence of psychological characteristics, emotional states, and habitual behaviors. Weaknesses include results related to individual characteristics cannot be over-looked and the possibility of possible bias related to self-reports may be present.

In the studies of Van der Schyff, Schiavio and Elliott (2023), Massie-Laberge (2019), Mierowsky, Marcus, Ayres (2020), Stevanovic, (2021), and Papazachariou-Christoforou (2022) combines musical environment, learning and embodied cognition, but the perspective directly on the prevention of musculoskeletal problems is missing and related to that reason form a sort of research category. In my opinion, however, the perspectives of the mentioned studies combine possible applicability around preventive teaching and healthy playing, including bodily engagement, movement-based and meaningful learning. In the study of Van der Schyff, Schiavio and Elliot (2023), the aim to critically understand enactive pedagogy based on theory is emphasized. My purpose is to understand how embodied cognition theory is reflected in practical applications or prevention strategies, and based on the preliminary review, not so much research could be found in relation to the assumption, and therefore the importance of the ontological basis of the theory related to terms of my thesis is highlighted. (Van der Schyff, Schiavioa and Elliott, 2023) As in the section related to research design, theoretical research has its own evaluation tools, but I do not consider it relevant for my thesis, which emphasizes practice, to evaluate the theoretical article

that is its individual supplement. The perspective of Massie-Laberge's dissertation (2019) focuses on the need to understand the body in relation to the musical structure and expression, physical and acoustic strategies. The point of view opens a more deeply described relationship, which may not be integrated in somatic methods as mentioned in the dissertation. (Massie-Laberge, 2019) Limitations are the same as those in other dissertations.

The study of Mierowsky, Marcus, Ayres (2020) considers embodied cognition, observational learning, and cognitive load theory from the perspective of optimizing music pedagogy and the learning environment. The research can provide a perspective on the connection between embodied cognition and music pedagogy, which is not directly addressed by research in the second category. In addition, the perspective to motor, cognitive and sports skills development can be applied to the area of preventive teaching development. In addition, it is interesting to try to understand what reducing the cognitive load means for music pedagogy and what opportunities it can provide for learning and concentrating energy. The disadvantages are that using subjective measures hinders the generalizability of the results, and as mentioned in the study, gestures could also have larger role in the future in relation to task complexity. (Mierowsky, Marcus, Ayres, 2020) Stevanovic's (2021) research considered the role of language in the body and musical environment through cognitive linguistics. The connection between music and language is an important topic in music science and it is meaningful to get to know a topic combining understanding the use of language through the role of language in embodied experiences and responses and body knowledge as well as music pedagogy. The study stands out from the others with its subject-specificity without a holistic perspective, which can on the other hand be a strength in terms of the goals of an integrative review. (Stevanovic, 2021) The study of Papazachariou-Christoforou (2022) process Laban's movement framework and focuses strongly on the role and interpretation of movement through aspects of embodied cognition. The strength of the work in terms of my thesis is the mentioned focus combined with learning and music and the effort to understand how movement and more specifically a movement-based framework is seen from the perspective of learning and whether the topic can be addressed from the perspective of preventive teaching. (Papazachariou-Christoforou, 2022) I also see it as important that motivation was in one way or another part of the aspects of the included studies.

## 2.2 Data Extraction and Analysis

| Prevention / Cognition / Musical environment | *Prevention* | *Relation to cognitive aspects* | *Pedagogy* | *Learning* |
|---|---|---|---|---|
| (Davies, 2020) | Alexander-technique, content was designed to target specific tension issues associated with playing | self as an active method of 'Psychophysical re-education', optimal sensory-motor control of head-neck-spine axis | communicating with hands, the study highlights the need for necessary training of performance-related health and prevention of pedagogues | included to rehearsing activity, whole-body coordination, enhance tone, technique, poise and musicality |
| (Kongpakpaisarn, 2020) | Taubman-approach, a specific system of movements based on kinesthetic awareness and biomechanics, tools for prevention and expression, piano | kinesthetic awareness, the instinctive use of bodily coordination and movements | divided into six areas: isolating, curling, twisting, stretching, collapsing and keybedding | musical requirements combined with healthy technique, instrument-specific suggestions for technique |
| (Détári, Nilssen, 2022) | 'Timani'-approach, functional instrument-specific body mechanics/ online sessions found to be effective | expanding movement options through enhancing proprioception, conscious awareness of a body part, muscle, or movement | targeted to dynamic performance context, seven parts: musician's anatomy, movement analysis, the fascia system, healthy natural breathing, ground force reaction, brain-body connection, awareness | posture, enhanced control in upper extremities, breathing mechanisms, the exercises are initially carried out away from the instrument, and then immediately integrated into the playing or singing |

| | | | | |
|---|---|---|---|---|
| (Rader, 2023) | Body-Mapping informed pedagogy, primary prevention | utilizing the senses, movement, and attention, body awareness as a function of interoception | focus on primary prevention education: Utilizing the senses, movement, and attention | beginning string students, understanding the size, structure, and function of the body in movement |
| (Sabo, Comeau, Guptill, Dvorkin, Russell, 2023) | Developing prevention by transforming the pedagogical language of Taubmann approach to the biomechanical language | mentions of extrapolation of knowledge, embodied experience and embodied knowledge | Initial motivation in scientific examination of pedagogical ideas and enhancing pedagogy utilizing interdisciplinary research | the inconsistent scientific use of knowledge by pedagogues is seen as a problem for learning preventive practices, external cues and challenges related to language |
| (Détári, 2023) | holistic disruption-oriented approach for treatment and prevention, task-specific focal dystonia, focus in social context | objectives in motor movement exercises intertwined in objectives regarding cognitive factors, “embodied and mental self-awareness”, “embodied sense of self”, “somatic focus”, “self-talk” | mental state and somatic learning cannot be separated, carefully selected nomenclature, “provoking experience”, situation-specific alignment of internal and external focus, effort-based praise, educators awareness of re-learning strategies and task-specific awareness, accessible tasks | knowledge is constructed as part of social activity |

Table 9 The First Category of Included Studies

In the first table of the included studies, the gaps addressed in the studies combined the needs with the applicability of prevention information. Rader (2023) and Davies

(2020) emphasized the importance of earlier introduction of prevention. Rader (2023) considers it important to pay attention to injury prevention tools in primary prevention and Davies (2020) considers prevention education and body awareness in more detail to proprioception and interoception, especially mentioning the gap in the study of interoception. Kongpakpaisarn's (2020) and Détari and Nilssen's (2022) studies were combined by increasing knowledge of body mechanics and biomechanics. According to Kongpakpaisarn (2020), in addition to intuitive experiential knowledge, a detailed study of techniques is needed, while Détari and Nilssen (2022) emphasize focusing on the efficiency of transmitting and utilizing information, highlighting somatic methods, which are usually focused on position and alignment instead of specific muscle groups. Sabo and the colleagues (2023) pointed out the paucity of generalizable knowledge in studies. According to Détari (2023), the role of musicians and teachers participating in the development of healthy practices, increasing understanding of specific problems and non-motor symptoms, is significant. (Davies, 2020; Kongpakpaisarn, 2020; Détári, Nilssen, 2022; Rader, 2023; Sabo, Comeau, Guptill, Dvorkin, Russell, 2023; Détári, 2023) Since all studies are recent, a temporal comparison in the change of focus is difficult to accomplish. According to a recent study, earlier implementation of prevention and more specific awareness of playing technique or biomechanical factors as well as symptoms and problems are emphasized in applicability. In the most significant gaps in the literature described by the studies, only body awareness factors and mentions of somatic methods can be connected to aspects of embodied cognition.

The first table of the studies focuses mainly on somatic methods, and they combine more specific perspectives related to unresolved playing-related musculoskeletal disorders risk factors, considering instrument-specificity, the relationship between the body and the instrument, as well as body mechanics and psychological factors. According to Davies (2020) muscle tension and stress being identified as primary predictors developing playing-related musculoskeletal problems. Kongpakpaisarn (2020) deals in detail with the physiology and risk factors of piano playing, which according to the Taubmann approach mean that tension occurs from co-contraction, awkward positions, excessive force and static muscular activity, and more precisely six causes of injury as described in approach are isolating (fingers lose connection with others and a static grip causes pain, fingers in contact with other parts of the hand), curling (hand position), twisting (wrist), stretching (assistance from the forearm is needed), collapsing (when nail joint, knuckle or wrist support disappears) and keybedding (suitable weight for the string). Détári and Nilssen (2022) emphasize the correction of body mechanics in dynamic performance context with the instrument and Rader (2023) opens that imbalance between areas of the body is a risk factor, especially for string

players. Sabo stresses the importance of biomechanical factors and the use of inconsistent scientific language among teachers. According to Détári (2023), the struggle with technical issues often takes years before the symptoms start. (Davies, 2020; Kongpakpaisarn, 2020; Détári, Nilssen, 2022; Rader, 2023; Sabo, Comeau, Gup-till, Dvorkin, Russell, 2023; Détári, 2023)

Four of the studies in the first table focus on preventive methods, which are the Alexander technique developed in turn of the 20th century, the Taubmann approach in the latter half of the 20th century, the Timani method since 2007, and the Body Mapping technique developed during the 1970's. One study focuses on the application of the Taubmann approach, and one is focused on symptoms, but with a connection to prevention in the learning environment. The Taubmann approach is focused on piano pedagogy. However, all methods emphasize their applicability. Alexander technique focuses on specific tension issues associated with playing and the lessons are scheduled in advance. Taubmann-approach is a specific system of movements based on kinesthetic awareness and biomechanics and combines prevention and tools for expression, and in biomechanics the load is thought to be evenly distributed between skeletal muscles and joints. The Timani approach includes instrument-specific body mechanics. In the body mapping technique, the focus is on primary prevention education utilizing the senses, movement, and attention. (Davies, 2020; Kongpakpaisarn, 2020; Détári, Nilssen, 2022; Rader, 2023; Sabo, Comeau, Guptill, Dvorkin, Russell, 2023; Détári, 2023) In the screening phase were noticeable that among the instrument-specific studies, the studies addressing piano pedagogy were highlighted in addition to the clinical studies. According to Kongpakpaisarn (2020) other methods suitable or developed for pianists are: “Ortmann’s The Physiological Mechanics of Piano Technique (1929), The Lister-Sink Method (Freeing the Caged Bird: Developing Well-Coordinated, Injury-Preventive Piano Technique… Sándor’s Technique (On Piano Playing: Motion, Sound, and Expression… and Alan Fraser’s Technique (The Craft of Piano Playing: A New Approach to Piano Technique… Alexander Technique (Body Learning: An Introduction to the Alexander Technique… and the Feldenkrais Method (Awareness Through Movement: Easy-to-do Health Exercises to Improve Your Posture, Vision, Imagination, and Personal Awareness…” (Kongpakpaisarn, 2020).

According to Détári's study (2023), it is important to understand that there is something bigger behind the specific symptoms and prevention should focus on the following: "(1) Learning environment, psychological support, and rapport (2) Somatic approaches (3) Focus, habits, and nomenclature.” (Détári, 2023) The learning environment includes a safe environment including holistic conversations, addressing anxiety and perfectionism, rapport, and shared experiences. In somatic methods, you must

focus by enhancing general body mechanics, reducing the fear of movement, and improving breathing mechanisms and considering musicians' previous experiences. The last point focuses on attentional focus and generating new experiences. According to Détári, channeling the focus of attention away from the affected body part can improve the motor symptoms and reduce the excessive need for control. Détári (2023) takes a stand on the contradiction of targeting focus away from the dividing line external and internal by introducing the somatic focus, which refers to targeting the sensations resulting from the interaction with the instrument (i.e., resonance) within the body, also mentioning that there is no literature available on the role of attentional focus and it could be worthy of detailed exploration. In addition, the research highlights the implicit body memory effect of the mention, which means that there are not only uncontrollable movement patterns, but the technique can also evoke habitual posture and breathing patterns and accompanying negative emotive states. (Détári, 2023)

In somatic education methods relation to cognitive aspects and conscious focusing of attention during learning in some way is common. In Davies' (2020) research on the Alexander technique developed by Frederick Matthias Alexander, attention is focused on the conscious alignment of focus to body functions, and it is described as the ability to recognize harmful neuromuscular patterning associated with tasks, and the conscious quieting of those responses, beginning with the neck muscles. Method highlights the "good tension", which refers to effectively support compressive forces both from gravity and various activities. Holistic thought is in the inhibition of stressful reactions and the development of constructive thought and movement patterns. Kongpakpaisarn's (2020) research Taubmann approach focuses on kinesthetic awareness, and it describes healthy movement with the help of descriptive language and mental images and that the healthy movement is ultimately instinctive and automatic. Détári and Nilssen (2022) talk about awareness factors by expanding movement options through enhancing proprioception, conscious awareness of a body part, muscle, or movement, while Rader (2023) by utilizing the senses, movement, and attention when body awareness is as a function of interoception. Sabo and colleagues (2023) talks about extrapolation of knowledge, concepts like embodied experience and embodied knowledge, opening that teachers try to evoke embodied experience in their students with subjective language and this can cause problems. In Détári's (2023) study, objectives in motor movement exercises are intertwined in objectives regarding cognitive factors using terms like "embodied and mental self-awareness", "embodied sense of self", "somatic focus" and "self-talk". According to the research, musicians' mental state cannot be separated from somatic learning and movement execution, and the relationship with the instrument and how the instrument is approached during

practice must also be considered. (Davies, 2020; Kongpakpaisarn, 2020; Détári, Nilssen, 2022; Rader, 2023; Sabo, Comeau, Guptill, Dvorkin, Russell, 2023; Détári, 2023)

Recent studies and dissertations on methods highlight the need for approaches that combine preventive activities with playing practice, as opposed to the 'Timani' approach (2022), where the exercises are firstly carried out away from the instrument and immediately integrated into the playing or singing. Differences in methods in pedagogical perspectives are caused by instrument-specificity, connection to musical aspects and details related to the emphasis on social context, teacher's and student's roles, mental state, and the meaning of focus. In Davies' study (2020), the pedagogy is focused on communicating with hands and the effects are visible in tone, technique, poise, and musicality. In Kongpakpaisarn's research (2020), the Taubmann-approach pedagogy developed by Dorothy Taubman is divided around the six risk factors mentioned, which are isolating, curling, twisting, stretching, collapsing and keybedding and aims to combine the interpretive and preventive factors of music. The most fundamental principle is bodily alignment, where the focus is to finger, hand, and arm functioning as a synchronized unit. The 'Timani' approach developed by Tina Margareta Nilssen, presented by Détári and Nilssen (2022), differs from the Alexander technique in that it emphasizes the usefulness of undetermined lessons, emphasizing the importance of dynamic performance context, and in it the pedagogy is divided into seven parts such as musician's anatomy, movement analysis, the fascia system, healthy natural breathing, ground force reaction, brain-body connection and awareness, also focusing on rebalancing self with the instrument and performance context. As an addition, the study mentioned that the method is also suitable for online sessions. (Davies, 2020; Kongpakpaisarn, 2020; Détári and Nilssen, 2022)

The Body Mapping technique of Rader's study (2023) was developed in the 1990s by Barbara and William Conable based on the principles of the Alexander technique. The motivation for developing the method was the observation that music students did not move their bodies according to anatomical actuality, but instead how they perceived their bodies to be, i.e., they moved according to their body maps. Body Mapping is movement education for changing musician's body maps and the focus is in primary prevention and it aims to utilize the senses, movement, and attention. Pedagogical perspectives of holistic disruption-oriented approach of Détári's research (2023) on prevention focus on carefully selected nomenclature, "provoking experience", situation-specific alignment of internal and external focus, effort-based praise, educators' awareness of re -learning strategies, task-specific awareness, and accessible tasks (breathing), emphasizing that somatic learning and mental state cannot be separated. Situation-specific alignment of focus means that internal focus when you the

work is focused on tensions, and external focus while performing must be taught. Recognizing mental state refers to understanding a situation where the emotional state affects motor activity. For example, a highly emotional interpretation can increase the load. By "provoking experience" the study refers to a practice in which the student affects the course of the teaching while exercising willpower. (Rader, 2023; Détári, 2023) Rader's research is the only one focusing on methods that clearly focuses on primary prevention.

The attitude towards movement aspects in learning differs in emphasis between different methods. In the Alexander technique presented by Davies (2020), the goal is ease of movement, whole-body coordination with 'neck release, head forward and up, back lengthen and widen' and the ability to learn the messages of the body's internal functions and thereby neuromechanical coordination and reducing excess muscle activation. Learning is part of the rehearsing activity and holistically targets the whole body and all movement activities including sitting, standing, and playing. Kongpakpaisarn's (2020) Taubmann approach emphasizes the instinctive use of bodily coordination and movement and the interpretation of movement through musical and technical challenges, and body movement has been applied specifically to musical requirements. Movement requirements are divided into strategies based on biomechanical and physiological principles, covering seating and posture, hand position, forearm rotation, in and out arm movements, walking hand and arm (referring to flexibility in movement), shaping (curvilinear and circular movements), grouping (mental breaths), leaps, interdependence (awareness of the relationship between the two hands and how they work together, one hand sends a movement to the other hand), fingering (to prevent injuries) and enslavement of notation (releasing the note). Problem points are illustrated using well-known musical works and their points with the help of a DVD. Détári, Nilssen (2022) and Détári (2023) deal with the importance of breathing mechanisms in connection with movement and that knowledge is constructed as part of social activity. Rader (2023) emphasizes the identification of body size structure and function as the time of movement. Finally, Sabo and colleagues (2023) sees movement learning as problematic if the scientific language used by the teacher is inconsistent. (Davies, 2020; Kongpakpaisarn, 2020; Détári, Nilssen, 2022; Rader, 2023; Sabo, Comeau, Guptill, Dvorkin, Russell, 2023; Détári, 2023)

| | | | | |
|---|---|---|---|---|
| Embodied cognition / Musical environment | *Perspective* | *Embodied cognition* | *Pedagogy* | *Learning* |

| | | | | |
|---|---|---|---|---|
| (Van der Schyff, Schiavio, Elliott, 2023) | Critical ontology for enactive music pedagogy | knowing, being, self-organizing and 'autopoietic' nature of the embodied musical mind | approaches based in possibility, imagination, and relationality | self- reflective process through the contextual sensorimotor interactions |
| (Massie-Laberge, 2019) | Expression and performance through kinematic, kinetic and perceptual analyses | the instrument as a natural extension of the musician's body | somatic approaches rarely integrate the body in relation to the musical structure and expression, physical and acoustic strategies | analyzing the nuances of body movements and connect them to specific structural aspects of the music |
| (Mierowsky, Marcus, Ayres, 2020) | considerations of embodied cognition, observational learning and cognitive load theory | gesturing (mimicking) strategies, studying by gesturing, exploiting primary knowledge | mimicking video animations / for future studies: aspects of optimizing learning environment, visual and motor experience of human movements | situated learning, learning advantage to gesturing with reduced cognitive load, efficacy of gesturing was influenced by learner's expertise and task complexity |
| (Stevanovic, 2021) | cognitive linguistics and conversation in analysis of instructive use of noun metaphors and metonymies | the role of language in embodied experiences and responses and body knowledge, metaphor as a resource of symmetricity | instructive use of noun metaphors and metonymies of behaviors related to the playing of a musical instrument, evaluating embodied knowledge, metaphor as encouraging tool | metaphor allows generating different alternatives to perceive and organize the world, problem solving, facilitating ear playing, creativity and movement learning |
| (Papazachariou-Christoforou, 2022) | Laban's movement framework | active bodily engagement, flow movement and embodied interaction with music | active bodily engagement: "effort elements" of time, space, weight, and flow / body awareness | acquiring a movement vocabulary is fundamental to fostering beat |

| | | | | |
|---|---|---|---|---|
| | | | and expressive movement, flow and nonlocomotory movement, locomotor movement with stylistic interpretation | competency and developing stylistic performance, experiencing music in overt 'whole body', developing musical understanding and beat competency |

Table 10 The Second Category of Included Studies

In the second table of the included studies, the gaps addressed focuses on the perspectives of more effective utilization of embodied cognition theory in music teaching and learning. The differences are related to the perspectives of the studies and the table describes the multidisciplinary and diverse perspectives. According to Van der Schyff, Schiavio and Elliott (2023), ontological education is presented as a reference framework for understanding primordial ways of being, including the self-organizing or 'autopoietic' nature of the embodied musical mind, and this enactive perspective is combined with the introduction of possibilities that support the well-being of music socially. (Van der Schyff, Schiavio and Elliott, 2023) According to Massie-Laberge (2019), the gap is related to the fact that somatic perspectives less often integrate the body in relation to the musical structure and expression, physical and acoustic strategies and the instrument is seen as a natural extension of the musician's body. Kinematic, kinetic and perceptual analyzes have been used as research tools. (Massie-Laberge, 2019) The study of Mierowsky, Marcus and Ayres (2020) a large part of gesture research is related to the topic of musician's listening to music and sees a gap in combining gesture research and observational learning related to cognitive load theory and gesturing (mimicking) strategies. According to the study, mimicking was useful for the less experienced, while the experienced had no benefit or even harm for some. (Mierowsky, Marcus and Ayres, 2020) Both Stevanovic (2021) and Papazachariou-Christoforou (2022) discuss the role of language in learning. Stevanovic (2021) discusses instructive use of noun metaphors and metonymies and Papazachariou-Christoforou (2022) Laban movement framework introducing the "effort elements" of time, space, weight, and flow and proposing that experiencing the components of those elements the movement vocabulary internalizes by fostering expressive music performance. (Stevanovic, 2021; Papazachariou-Christoforou, 2022)

In my opinion, the sources combine ways of thinking, being, the naturalness of playing, music, and health in a closely integrated way. The sources also emphasize the idea of the meaning of effort through cognition, natural movement or expressiveness and movement. The importance of age and playing level is also considered. More specifically, in relation to cognitive aspects, the sources combine ways of exploiting experiential embodied knowledge and embodied interaction through active bodily engagement in varying ways. In studies of bodily cognition, ways to utilize primal and reactive consciousness and ways to become aware of its operation as part of learning are emphasized. Van der Schyff, Schiavio and Elliot (2023) present life as self-organized and this basis causes profound effects on ontological, pedagogical, and cognitive perspectives. (Van der Schyff, 2023) According to Mierowsky, Marcus and Ayres (2020) primary knowledge means knowledge that has developed over time and is available fairly easily with only a small cognitive load, and observational learning consists of primary knowledge skills. An example of this is facial recognition and imitating others. (Mierowsky, Marcus and Ayres, 2020) Stevanovic (2021) considered the role of language in embodied experiences and responses and describes how metaphor creates connections between music, emotion and bodily experiences, for example by describing the relationship between body position and an object, for example by words " tree" or "birdnest", while metonymy can refer to body parts given the status of the entire person for example "playing fingers" or "playing feet". (Stevanovic, 2021) Papazachariou-Christoforou (2022) discusses active physical participation and flow in movement in relation to learning in pre-school children. (Papazachariou-Christoforou, 2022) In three of the five studies, the special target group is small children and children, and I see it as important from the point of view of preventive practice to recognize the basis of being and learning, the understanding of which can possibly also serve older students.

In Van der Schyff and Elliott's (2023) study, the pedagogical perspective wraps around enactive music pedagogy related to the factors of possibility, imagination and relationality and encourages the perspective of pedagogy to consider a more self-reflective perspective relating to the meaning of presence. The study considers how a modern perspective can obscure the ethical, ontological and epistemological aspects of teaching possibilities. (Van der Schyff, Schiavio and Elliott, 2023) Massie-Laberge's (2019) study concerns piano pedagogy and present piano pedagogy often focusing specifically on arms and hands being in the heart of learning instrumental technique. According to Massie-Laberge, other types of body movements, which coexist with the gestures involved in the production of the sound, should be included in the development of a more systematic pedagogical practice that supports musical communication ability. (Massie-Laberge, 2019) Mierowsky, Marcus and Ayres (2020) suggest that the

pedagogical perspective would develop by considering in addition to gestural knowledge, learning environment optimization where visual and motor experience of human movements is further considered. (Mierowsky, Marcus, Ayres, 2020) Stevanovic (2021) presents a pedagogical perspective through metaphor and metonymies as a resource for the teacher to evaluate and monitor the level and development of the student's body knowledge and metaphor being encouraging tool and more broadly maintaining playfulness, imagination and creativity are the most important motivating factors. (Stevanovic, 2021) Papazachariou-Christoforou (2022) describes Laban's framework as follows: "1. Time refers to how sustained or quick the movement is. 2. Weight refers to how strong or gentle the movement of the body is. 3. Space refers to the direction of movement. 4. Flow refers to how free or bound the bodily tension is." Framework utilizes Imaginary scenarios framing the movement, focusing specifically on locomotor movement activities. (Papazachariou-Christoforou, 2022)

In my opinion, the perspectives combine the teacher's role, which is based on self-reflection and considering human movement more broadly as a part of cognitive activity, considering the free and easy activity of the student and the effects of motivating factors in a constantly changing environment. Van der Schyff, Schiavio and Elliott (2023) discusses learning, describing it as a self-reflective process through the contextual sensorimotor interactions. They see "being-as-learning" through more primordial and situated understanding of learning and how basic sensorimotor intelligence develops into a rich understanding of a self. In the study embodied, adaptive, situated and contextual knowing is seen to develop in an active environment collectively and individually. (Van der Schyff, Schiavio and Elliott, 2023) Massie-Laberge (2019) consider learning through a more holistic movement analysis and how the nuances of body movements connect to specific structural aspects in music. The benefit of learning is seen as the ability to compare one's own movements with those of experienced ones and to become more aware of the effect of movement on one's musical communication ability. (Massie-Laberge, 2019) As mentioned, Mierowsky, Marcus and Ayres (2020) see observational learning strategies as particularly useful for beginners. (Mierowsky, Marcus and Ayres, 2020) According to Stevanovic (2021), alternative ways of dealing with the world, problem solving, ear playing, creativity and movement learning develop with the help of metaphors, and according to evidence in Papazachariou-Christoforou study (2022), business vocabulary has a fundamental meaning in fostering beat competence. Free-flowing movement as part of musical engagement removes tension in the body. Papazachariou-Christoforou's research describes musical engagement as "musical thinking being an internalized form of movement" or saying that "we listen to music with our muscles" (Stevanovic, 2021; Papazachariou-Christoforou, 2022) In my opinion, the studies combine different forms of communication and

interaction factors, especially from the point of view of learning, as part of more primordial movement or movement awareness.

# 3 FINDINGS

## 3.1 Summary and Search Results

During the content and comparative analysis, the synthesis developed around two high-level themes from the perspective of developing preventive practice: 1) Embodiment and Embodied Self-Regulation and 2) Environment in Cognitive Strategies. Based on the content analysis, the first section was shaped into subthemes related to the possibilities in terms of body movement and cognition, endogenous attention and senses in cognitive strategies, embodied knowledge and embodiment as well as internal representations. The second section considered environmental aspects of learning and cognitive strategies related to environmental factors. I discussed the results of the integrative review in the reference framework developed during the preliminary review with the aim of outlining the possible role of embodied cognition combined with the literature related to prevention of musician's musculoskeletal problems in learning environment in the section 4.1. Based on the synthesis results, research program of embodied cognition could bring added value to the development of prevention of musician's musculoskeletal problems in the learning environment by considering embodied and environmental cues, embodied music cognition, ontological questions related to embodiment and several environmental practical aspects in relation to the sensory and attentional control-focused perspectives of somatic methods.

## 3.2 Analysis and Synthesis

Based on the internal comparison of the first category, the sources are united by the review of already existing somatic or preventive methods, and they are related to the roles of the senses, mainly interoception combined with body awareness, motion senses, proprioception, and body and biomechanics and sensorimotor aspects in a preventive learning environment. The studies are distinguished by their emphasis to the level of conscious control of embodied functions, instrument specificity or application to several instruments, and factors related to the target group of prevention. (Davies, 2020; Kongpakpaisarn, 2020; Détári, Nilssen, 2022; Rader, 2023; Sabo, Comeau, Guptill, Dvorkin, Russell, 2023; Détári, 2023) In the internal comparison of the second category, the variation of topics as music, environment, and imagery are emphasized particularly in the embodied experience. The distinguishing factors were the differences in the focus related to movement, senses, music or imagery and their utilization in learning. (Van der Schyff, Schiavio, Elliott, 2023; Massie-Laberge, 2019; Mierowsky, Marcus, Ayres, 2020; Stevanovic, 2021; Papazachariou-Christoforou, 2022) A comparison of the categories shows that the factors connecting the sources include understanding the role of embodied in being, moving and self- -regulation in the learning environment, as well as the importance of the environment and its utilization in cognitive strategies. Second category emphasizes more exogenous attention and unconscious aspects of learning as well as the roles of language, music and environment. In the first category attentional control and movement senses are more emphasized. (Davies, 2020; Kongpakpaisarn, 2020; Détári, Nilssen, 2022; Rader, 2023; Sabo, Comeau, Guptill, Dvorkin, Russell, 2023; Détári, 2023; Van der Schyff, Schiavio, Elliott, 2023; Massie-Laberge, 2019; Mierowsky, Marcus, Ayres, 2020; Stevanovic, 2021; Papazachariou-Christoforou, 2022).

According to embodied cognition, motor, sensory and cognitive systems are in close interaction. (Sullivan, 2018) Specifically in sections considering learning and cognition, different emphases on sensory, motor and cognitive aspects appear, as well as emphases related to movement, sensory experiences or the part of the body with attentional control and their importance in learning. In the studies considering preventive education, attentional control, perception, directing attentional focus, knowledge of the body (interoception), and posture and movement sense (proprioception) were emphasized. Davies (2020) emphasizes the sensorimotor control being as basis for cognition and sensorimotor skills as part of getting to know the environment, and the ability to pay attention is connected to sensorimotor control and global coordination. According to Sabo, Comeau, Guptill, Dvorkin and Russell (2023) embodied knowledge and

experience are discussed and Détári (2023) discuss somatic focus and embodied sense of self and self-awareness. Kongpakpaisarn's (2020) connection to the senses is related to kinesthetic awareness and instinctive use of movements, while Détári and Nilssen's (2022) sense-activity through proprioception and conscious awareness. Rader (2023) also focuses on conscious awareness, emphasizing interoception. (Davies, 2020; Kongpakpaisarn, 2020; Détári, Nilssen, 2022; Rader, 2023; Sabo, Comeau, Guptill, Dvorkin, Russell, 2023; Détári, 2023) Research therefore approaches preventive learning through control of the 'whole body', directed attention or instinctive action. In the studies of embodied cognition of the second category, music was more closely part of the cognition, as in the studies of Massie-Laberge (2019) and Papazachariou-Christoforou (2022), as well as self-organizing activity, gestures and primary knowledge. Compared to the studies of the first category, less conscious control can be observed being part of the learning, for example in relation to the connection between language and body awareness, primary knowledge and self-organizing activity. (Van der Schyff, Schiavio, Elliott, 2023; Massie-Laberge, 2019; Mierowsky, Marcus, Ayres, 2020; Stevanovic, 2021; Papazachariou-Christoforou, 2022)

The studies in the first category considers more closely the body or healthy movement through the comprehensive approach, such as with whole-body coordination, understanding the meaning of the body's structure and function in movement with the help of mental images or focusing on controlling the upper extremities, or internal representations can be utilized in musical requirements as part of healthy movement. (Davies, 2020; Kongpakpaisarn, 2020; Détári, Nilssen, 2022; Rader, 2023; Sabo, Comeau, Guptill, Dvorkin, Russell, 2023; Détári, 2023) In the second category, the role of language and social environment in the movement was emphasized. Stevanovic's (2021) research considers the role of language in the whole uniting movement and senses, or metaphors as an aid to learning movement and problem solving (Stevanovic, 2021). Papazachariou-Christoforou (2022) consider experiencing music in overt 'whole body' with movement vocabulary. (Papazachariou-Christoforou, 2022) Challenges related to language and social activity in knowledge construction were also discussed (Sabo, Comeau, Guptill, Dvorkin, Russell, 2023; Détári, 2023) Primary knowledge, on the other hand, refers to information that we utilize quickly and effortlessly and is the utilization of information that is not actively controlled. (Massie-Laberge, 2019) In the research, the structural features of music have been brought into the equation of cognition and movement, or in such a way that the nuances of body functions are combined with the structural features of music. (Mierowsky, Marcus, Ayres, 2020) All included studies emphasize bodily alignment, but Papazachariou-Christoforou's (2022) study deepen the definition of active bodily alignment and embodied interaction with music. (Papazachariou-Christoforou, 2022)

More precisely, the pedagogical goals of the studies were approached through specific tension issues and communicating with hands, as in Davies's (2020) study or as in Kongpakpaisarn's (2020), combining prevention, biomechanics and expressiveness. Détári and Nilssen (2022) emphasized functional instrument-specific body mechanics, Rader (2023) primary prevention and Sabo, Comeau, Guptill, Dvorkin and Russell (2023) interdisciplinary research and Détári (2023) the holistic disruption-oriented approach for embodiment. In the second category, pedagogy emphasized ontology, possibility, imagination, and relationality in Van der Schyff, Schiavio, Elliott study (2023) body in relation to the musical structure and expression, physical and acoustic properties in Massie- Laberge's study (2019). In Mierowsky, Marcus, Ayres study (2020) emphasized observational learning and cognitive load theory, optimizing learning environment through experience. Stevanovic (2021) emphasized the teacher's language use and Papazachariou-Christoforou (2022) Laban movement framework and "effort elements" of time, space, weight, and flow with non-locomotor and locomotor movements. Variation in the included studies in whether the movements are considered through conscious control or instinct, and in what ways information is acquired, and how the activity is embedded in the environment, or the body is noticeable. Searching for difference's demonstrates how embodied cognition and research not related to it have been done with otherwise the same subject emphasis. There are differences between the categories in the approach to the level of control, in which senses are emphasized and whether movement senses are combined or the activities of movements and other senses in teaching. There are differences in discussion about environmental factors and their role, or in the utilization of internal representations in teaching. In the first category, the attentional control is more focused on body parts or bodily sensations in the space, while in the second category emphasize the environmental aspects related to directing attention or to the exogenity of the attention. Through the comparison, the emerged questions related to level of approach to the control of bodily functions and what kind of attentional control is justified for the student's learning in terms of health or development.

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| ”sensory-motor control and global coordination” (Davies, 2020) “incorporate…movements in such a way that they become invisible to the eyes”, “principles… become instinctive and automatic” (Kongpakpaisarn, 2020) “conscious awareness of a body part, muscle, or movement” (Détári, Nilssen, 2022) “body movement alters interoception” (Rader, 2023) “The body can be a site of knowledge production” (Sabo, Comeau, Guptill, Dvorkin, Russell, 2023) “targeted movement exercises…directing attentional focus” (Détári, 2023) | Body movement and cognition |

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| “when a focus on techné obscures the other three elements (poiēsis, theoria, phronēsis) all connection to praxis is lost. (Van der Schyff, Schiavio, Elliott, 2023) “normal, deadpan, exaggerated and immobile conditions” (Massie-Laberge, 2019) “gesturing techniques”, “body knowledge” (Mierowsky, Marcus, Ayres, 2020) “metaphors and metonymies of body position” (Stevanovic, 2021) “incorporating a gesture using a combination of locomotor and nonlocomotor movements” (Papazachariou-Christoforou, 2022)<br><br>“kinesthetic learning”, “thinking with gestures”, “grounding knowledge to motor experience”, “motor simulation”, “expressivity”, “situated learning”, “metaphoric gestures”, “dynamic depictive gestures” (1.2.1.3) | |
| ”conscious quieting”, “primary control” (Davies, 2020) “body mechanics… interpretation and musical expressiveness” (Kongpakpaisarn, 2020) “bodily sensations”, “conscious awareness of a body part, muscle, or movement” (Détári, Nilssen, 2022) “interoceptive awareness”, “proprioception” (Rader, 2023) “biomechanical language” (Sabo, Comeau, Guptill, Dvorkin, Russell, 2023) “external focus… internal focus” (Détári, 2023)<br><br>“enactive relational autonomy”, “participatory sense-making” (Van der Schyff, Schiavio, Elliott, 2023) “motion cues” (Massie-Laberge, 2019) “gesturing while observing” (Mierowsky, Marcus, Ayres, 2020) “body knowledge through metaphors and metonymies” (Stevanovic, 2021) “musical thinking as an internalized form of movement” (Papazachariou-Christoforou, 2022) | Endogenous attention and senses in cognitive strategies |
| “sense of optimal functioning in gravity” (Davies, 2020) “the instinctive use of bodily coordination and movements” (Kongpakpaisarn, 2020) “embodied knowledge” (Détári, Nilssen, 2022) “body awareness dynamical interactive process”, “embodied experience” (Rader, 2023) ”the body can be a site of knowledge production” (Sabo, Comeau, Guptill, Dvorkin, Russell, 2023) “broader sense of their body mechanics, i.e., embodiment”, “embodied and mental self-awareness” (Détári, 2023)<br><br>“self-organizing or ‘autopoietic’ nature of the embodied musical mind”, “coordinating action through dynamic adaptive processes”, “self-reflective understandings…” (Van der Schyff, Schiavio, Elliott, 2023) “embodied music cognition” (Massie-Laberge, 2019) “primary knowledge” (Mierowsky, Marcus, Ayres, 2020) “metaphorical concepts as cognitive constructs | Embodied knowledge and embodiment |

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| can also emerge independent of language" (Stevanovic, 2021) "explicit musical representational knowledge" (Papazachariou-Christoforou, 2022)<br><br>"endogenous embodiment", "self-organization", "Bayesian brain and predictive coding", "error-correction and motor adaptation in learning", "the role of long-term process", "exogenous embodiment" (1.2.1.3) | |
| "faulty internal body schema ('body maps') are… retrained" (Davies, 2020) emphasis on internal senses and representations (Kongpakpaisarn, 2020) "avoided abstract language or metaphors" (Détári, Nilssen, 2022) "neural representations" (Rader, 2023) "biomechanical language" (Sabo, Comeau, Guptill, Dvorkin, Russell, 2023) "self-talk" (Détári, 2023)<br><br>"phronēsis" (Van der Schyff, Schiavio, Elliott, 2023) "emotional intentions" (Massie-Laberge, 2019) "mimicking gestures" (Mierowsky, Marcus, Ayres, 2020) "mimicking gestures", "metaphor may add to the experience of movement an affective component" (Stevanovic, 2021) "imaginary scenarios to embody" (Papazachariou-Christoforou, 2022)<br><br>"embodied simulation", "creativity and embodied metaphors" (1.2.1.3) | Internal representations |
| " tension and stress… identified as primary predictors", "gravity… proprioception", "use of whole self" (Davies, 2020) relation to instrument, "a "profound sense of rest, like resting intimately with the instrument."" (Kongpakpaisarn, 2020) "demonstrations and visual aids", "dynamic performance context" (Détári, Nilssen, 2022) "dynamical interactive process", "primary prevention" (Rader, 2023) … (Sabo, Comeau, Guptill, Dvorkin, Russell, 2023) "socially prescribed perfectionism", "need to control", "Instructing… to direct their attentional focus" (Détári, 2023)<br><br>"dynamic adaptive processes", "forces that shape identity and consciousness", "a primordial embodied way of contextually situated knowing", "phronētic practices", "autopoiesis as a guiding principle" (Van der Schyff, Schiavio, Elliott, 2023) "guides… to connect their movements to the structural and stylistic features of a piece", "is not concerned with the internal or external forces that cause the movement" (Massie-Laberge, 2019) "primary knowledge", "gesturing" (Mierowsky, Marcus, Ayres, 2020) "metaphors and metonymies as interactional resources" (Stevanovic, 2021) "focus on meter and rhythm, melodic contour, form, dynamics, and the | The environment and exogenous attention in cognitive strategies |

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| expressive qualities of music" (Papazachariou-Christoforou, 2022)<br><br>"situation -specific way of coping", "improvisational and informal musical learning", "exogenous embodiment", "sensorimotor exploration", "human- and technologycentered methods", "active object manipulation", "gestures", "imitation", "visual stimulation", "collaboration", "emotional component of music education", "interactive musical learning", "enactive approaches" (1.2.1.3) | |

Table 11 Table of Content Analysis

Based on a comparative and content analysis, the synthesis studies took shape around two high-level themes, one of which emphasizes questions and cognitive strategies related to being, the student's perspective and aspects related to self-regulation. In the second theme, the factors related to the environment, the cognitive strategies related to the utilization of the environment and the teacher's role in them are emphasized. Regarding the first section, the topic is divided into sub-topics considering the relations between body movement and cognitive functions, endogenous attention and senses in cognitive strategies, embodied knowledge and embodiment as well as topic related to exploiting internal representations. The second section considers topics related to environment and exogenous attention in cognitive strategies. According to my assessment, the cognitive functions divided into the mentioned two themes clarify practical understanding of the experience of the teacher and the student in the learning situation. The dividing line is also justified based on the preliminary review because the important preventive factors are divided into cognitive strategies and other external factors. The dividing lines of the synthesis continue to develop to understand the role of internal cues, self-regulation and the environment in cognitive strategies, as well as the role of external factors in cognitive functions and in comprehensive movement that supports health and growth during learning, and furthermore emphasizes how cognitive functions are an inseparable part of preventive psychophysical development. In my opinion, the added value of embodied cognition for synthesis considering cognitive functions as part of the environment and in relation to external factors in learning, can also be used to understand and develop themes emerged from research regarding prevention of musician's musculoskeletal problems.

### 3.2.1 Embodiment and Embodied Self-Regulation

As stated in the preliminary review, cognition in relation to my thesis topic has so far been considered mainly within the framework of the somatic methods, where the connection between body movements, body use and cognition is emphasized. Therefore, connections of other subjects than somatic methods related to body movement and cognition can only be tentatively evaluated in connection with preventive learning environment. In the included studies, possibilities in terms of movement and cognition have been approached from a variety of perspectives, which could have added value for the development of movement principles of preventive teaching in addition to the perspectives offered by somatic methods. The included studies consider the connection between images and movements, which is an important theme in many studies, but especially in Papazachariou-Christoforou (2022) and Stevanovic (2021) studies, as well as expressiveness by discussing the relationship between movement and interpretation in the study of Massie-Laberge (2019). The body as a producer of information is emphasized in several studies. The body is treated as a storage of information in Sullivan (2018) research and emphasizing the benefits of unconscious activity emerge in Kongpakpaisarn (2020), Stevanovic (2021), Massie-Laberge (2019), Rader (2023) Mierowsky, Marcus, Ayres (2020) and Détári (2023) studies and the focus on conscious action and attentional focus emerge in Détári (2023) and Davies (2020) and Détári, Nilssen (2022) studies. In addition, the studies of Massie-Laberge (2019) and Rader (2023) specifically discuss the fact that movement changes cognition. In this context, the use of gestures is emphasized, such as metaphoric in Stevanovic (2021) and Kongpakpaisarn (2020) study or dynamic descriptive gestures in Massie-Laberge (2019) study and the concept of thinking with gestures in Shapiro and Stolz (2018) study. Discussion about cognition being used for controlling movement in a healthier way, for example with the help of motor simulation emerged in preliminary review. In connection with body movement and cognition, the concept of situated learning discussed by Van der Schyff, Schiavio and Elliott (2023), where the active use of the body plays a role in learning, is emphasized.

The study (2016) describes technical knowledge as follows: "when a focus on *techné* obscures the other three elements (*poiēsis, theoria, phronēsis*) all connection to *praxis* is lost." In the study (2016), the Greek concept of techné is intertwined with the terms poiēsis or being-as-production and is enmeshed in the process as a continuous system where technical knowledge is not an end in itself but a wider part of human flourishing and the term phronēsis as follows: "fundamentally caring way we orient ourselves... The knowledge (and action) associated with phronēsis is therefore inherently embodied and affective; it includes the ongoing development of pragmatic 'knowing-

how' that takes relevant circumstances into account (Van der Schyff, Schiavio, Elliott, 2023) More precisely, relation of conscious awareness and movements is discussed by Détári (2023) with targeted movement exercises and directing attentional focus, by Davies (2020) with sensory-motor control and global coordination, where the focus is on the overall state of the body and by Détári, Nilssen (2022) with conscious awareness of a body part, muscle, or movement. On the one hand, attentional control with imagery and metaphors can be seen as important, especially in primary prevention, influencing imagery by incorporating a gesture using a combination of locomotor and nonlocomotor movements (Papazachariou-Christoforou; 2022) or movement with metaphors and metonymies of body position (Stevanovic; 2021). In Détári (2023) research, directing attentional focus is used by aiming at something or away from something to achieve a healthy technique and mind. In turn, giving up the goal of control and utilizing unconscious activity or primary knowledge in the implementation of healthy movements is emphasized. In Kongpakpaisarn (2020) study goal where movement principles become instinctive and automatic is seen as important and Sabo, Comeau, Guptill, Dvorkin and Russell (2023) mentions that body can be a site of knowledge production. Mierowsky, Marcus and Ayres (2020) emphasizes the use of intuitive primary knowledge related to facial recognition, where gesturing techniques are combined with a reduction in cognitive load and hence time efficiency.

In the preliminary review, the topic including the effects of movement on cognition is highlighted in the Shapiro and Stolz (2018) study with the mention of thinking with gestures, which refers to the skill of recognizing information hidden in gestures. In the studies of Massie-Laberge (2019) and Rader (2023), the effects of movement on cognition were discussed through the knowledge of movement changing cognition. Massie-Laberge (2019) stated the effects of movement on cognition by becoming aware of the effect of the movement on the communication of expressive and structural parameters. Based on Massie-Laberge's (2019) research, I would see that expressivity principles can play a role in healthy movement planning, which was examined in the study using normal, deadpan, exaggerated and immobile conditions. The study (2019) emphasizes that kinematics is not concerned with the internal or external forces that cause the movement and the emphasis is on what kind of gestures could help in planning healthy movement and interpretation. In the study (2016) it was mentioned, for example how movement was found to have a more precise effect on the ability to listen, with the mention that while restricting the movements the focus was put on listening to the performance or how the role of the pelvis in the whole was decisive. In addition, the strategies emphasized the connection between body movement and timing and weight compensation strategies in relation to structural parameters. Rader (2023), on the other hand discussed the effects of movement on cognition by body movement

altering interoception affecting not only awareness but also the ability to change movement. According to Rader (2023) the mention is significant for learning because the development of interoception was found to be effective for self-regulation, attention regulation, and body listening. Healthy movement and achieving healthier movement through cognitive activity are presented in Sabo, Comeau, Guptill, Dvorkin, Russell (2023) study with Taubmann approach, Détári and Nilssen (2022) study with Timani method, Rader (2023) study with Body Mapping and Papazachariou -Christoforou (2022) study with Laban movement framework, more detailed in section 3.2.2. Findings related to body movement and cognition in included studies suggests that the connection between movement and cognition in practice is related to healthier playing technique and development.

The perspective of the included studies for embodiment of learning is illustrated through various concepts that describe being, knowing, factors affecting learning, physicality of cognitive functions and abilities, ways of processing information and experiencing. As Shapiro and Spaulding (2021) stated, understanding embodied cognition requires a more detailed study of the body's sensory and motor mechanisms. According to Leman and colleagues (2018), with embodied cognition we can simplify our understanding of the nature of the body and become more aware of the factors and goals that affect learning and being. Cognitive functions include for example functions affecting perception, memory, learning, attention, decision-making, and language processing. (American Psychological Association, 2018) As data extraction showed, internal representations and sensory information were emphasized in the processing of perception in the included studies, especially proprioception and interoception. The embodied role of memory and learning was reflected in topics by considering reducing working memory load, in the role of body memory in the acquisition of movements and emotional states and in the comprehensiveness of movements as supporting memory. Sullivan's (2018) research evaluates how explicit and implicit memory are better when input presentation is embodied and how the gestures can help form more elaborative memories. Explicit memory refers to long-term memory, where previous experiences and concepts are deliberately remembered, while implicit memory refers to the unconscious use and acquisition of memory (Sullivan, 2018) Mierowsky, Marcus, Ayres (2020) study shows how the load of working memory is reduced when primary knowledge and imitation are utilized and how its importance is highlighted especially in cognitively more difficult secondary knowledge acquisition. In Detari's (2023) study, implicit body memory was treated in the rehabilitation of musician's focal dystonia. The concept refers to the fact that, in addition to involuntary movements, the technique can evoke habitual posture and breathing habits and related negative emotional states, and in the case of a triggering task, it can be said that

the hand remembers something. Kongpakpaisarn (2020) presents the concept of interpedence by discussing alternating hands and hands working as one well-functioning duo and how related exercises strengthen memory.

The studies consider knowing and the body as a source and developer of knowledge through feelings and bodily sensations. Détári, Nilssen (2022) combines the development of the concept of embodied knowledge as one of the benefits of the Timani method, and this refers to embodied feelings such as feelings at more ease or grounded or feeling of more space or capacity to breathe. In Rader's (2023) study on Body-Mapping informed pedagogy, important themes emerged as communities supporting music, classroom development, somatic awareness, and understanding of the embodied experience. By embodied experience the study refers to descriptions of bodily sensations. Sabo, Comeau, Guptill, Dvorkin and Russell (2023) describes how the body can be a site of knowledge production. According to Papazachariou-Christoforou's (2022) research, early participation in music-making with meaningful movement activities helps in generating explicit musical representational knowledge and with it, children teach themselves music when emerged in music play. In Massie-Laberge's (2019) study, embodied music cognition is treated as a perspective relevant to the development of pedagogy, because it recognizes the instrument as a natural extension of the body, integrating body movements other than those inspired by virtuoso technique, which occur in parallel with gestures in sound production. In some of the studies, the considering embodiment can be seen as going beyond the concept of kinesthetic learning. Détári (2023) approached embodiment being broader sense of body mechanics and presenting the concepts embodied and mental self-awareness. By broader sense the study refers to cognitive element of the therapy where movements are approached from a holistic perspective taking into account larger structures of body and the rehabilitation of the motor function being inseparable from the reappraisal of the accompanying emotions. Rader (2023) presents body awareness being dynamical interactive process. In the study of Van der Schyff, Schiavio and Elliott (2023), the perspective can be seen through the concepts self-organizing or 'autopoietic' nature of the embodied musical mind, coordinating action through dynamic adaptive processes as well as self-reflective understanding what means to be and become a learner and teacher. The concepts endogenous embodiment, self-organization, Bayesian brain and predictive coding and exogenous embodiment from the preliminary review are part of the conceptual framework referring to the understanding of embodied being.

Endogenous attention refers to attentional control, i.e. conscious attention and decisions about what to pay attention to and what to ignore. (Astle and Scerif, 2009) The

theme summarize the understanding of how the studies consider conscious control related to learning and practice related to it. Van der Schyff, Schiavio and Elliott (2023) mentioned that embodied cognition theory emphasizes how the student learns how to teach himself and in this context the concepts enactive relational autonomy and participatory sense-making are used, which refer to the dynamical and ontological nature of the group's difference. In my opinion, teaching conscious bodily control and attention could be assessed as appropriate to the mentioned philosophical viewpoints, and as Rader (2023) stated, self-regulation is a preventive factor for musculoskeletal problems. Détári's (2023) concepts external, internal and somatic focus are related in therapeutic use to consciously directing the focus of attention. External focus can be used, for example, when performing, while internal focus can be emphasized while working with tensions. Somatic focus is referred to in the study as follows "... targeting the sensations resulting from the interaction with the instrument (i.e., resonance) within the body, and found that this condition was superior to both internal and external conditions in terms of movement effectiveness" (Détári, 2023) . The physicality of information processing and the ways to utilize endogenous attention vary in studies. In the preliminary review, an example of the embodied information processing was the use of representations, for example through embodied simulation or simulating experience while listening. Davies (2020) consider attentional control by consciously quieting responses beginning with neck muscles and the relationship with the environment can be seen in the goal to sense optimal functioning in gravity. This control of the entity is described by the term primary control. Kongpakpaisarn's (2020) emphasis is distinguished by the goal of instinct use of body. Détári and Nilssen (2022) deals with directing attention to bodily sensations or conscious awareness of a body part, muscle, or movement. In Massie-Laberge's (2019) study, attention is directed to motion cues, and Mierowsky, Marcus, Ayres (2020) to gesturing while observing. In Papazachariou-Christoforou's (2022) study musical thinking is seeing as an internalized form of movement and it is mentioned that we listen to music with our muscles. Rader (2023) describes focusing attention through interoceptive awareness and proprioception. All studies consider the allocation of attention through embodied experience to some extent.

Information is also processed with the help of gestures that make use of the body's position and relationship to the environment. The embodied nature of language was emphasized in studies of Stevanovic (2021) and Sabo, Comeau, Guptill, Dvorkin, Russell (2023) regarding body knowledge through metaphors and metonymies or biomechanical language. According to Stevanovic (2021) "embodied experiences, such as using one's body to navigate space, motions, and balance, give rise to more abstract cognitive concepts, such as time and causality, while language plays an active role in these

concepts. Both metaphor and metonymy are part of this mechanism, which involves language both as grounded in lived human experiences and as reflecting how we perceive, understand, and interact with these experiences". In addition, Stevanovic mentions that metaphorical concepts as cognitive constructs can emerge independent of language. Similarly, Sabo and colleagues (2023) approach the use of metaphor critically from the perspective of biomechanical language. The emphasis in introducing biomechanical language emphasizes that using metaphors requires a better extrapolation of information in order to make the language biomechanically clear. Language is one of the triggers of internal representations. In all studies, the utilization of internal representations and the embodied nature in them were emphasized in one way or another. According to NLP World (2021) internal representations refers to the content of our thinking or the confirmation of information which includes pictures, sounds, feelings, tastes, smells, and self-talk. (NLP World, 2021) The research program of embodied cognition also includes the concept of grounded cognition: "Grounded cognition is still about mental representations, just ones that are shaped by the body. The key move is the grounding, shaping internal content with external, modality specific factors. Embodied cognition replaces representations with our activity in a richly perceived world." (psychsciencenotes.blogspot.com, 2013)

In Kongpakpaisarn (2020) study, the embodied nature of language and the goal to minimize the movement or by imagining external spontaneous images was shown, for example, as follows: "holding lightly...(feeling of hovering)...sound and feel smooth... profound sense of rest , like resting intimately with the instrument… the feeling of falling into a hole while walking… feel "down" on each note… the glimmering candle-end before the frightening creature vanishes into the night sky." (Kongpakpaisarn, 2020) In the included studies, the importance of internal representations was seen in several ways, combining images and movement, utilizing the surrounding space and imaginary scenarios to embody, as in Laban's movement Framework presented by Papazachariou-Christoforou (2020), or neural representations, which refers to dynamical interactive process of body awareness and representations of embodied experience in the body mapping informed pedagogy introduced by Rader (2023). Détári, Nilssen (2022) study avoided abstract language or metaphors. In Davies' (2020) study, representations occurred by retraining faulty internal body schema, i.e. body maps. As mentioned in Kongpakpaisarn's (2020) study, internal representations focus on descriptions of the connection between musical parameters and body movements and the environment. In Détár's (2023) study, there is a reference to repeated self-talk, which is described as follows: "It's like a little devil sitting on your shoulder [the fear and anxiety], and it is talking into your ear. And if you recognize: oh, hello, it's you, there you are (makes plucking noise, imitates flicking something away). You're not

necessary!". (Rader, 2023) Massie- laberge's (2019) study mentions the study of how emotional intentions were conveyed through musician's movements. Mierowsky, Marcus and Ayres (2020) and Stevanovic (2021) discussed mimicking gestures and as Stevanovic (2021) mentioned that metaphor may add to the experience of movement an affective component.

According to Van der Schyff, Schiavio and Elliott (2023), mental images are part of the ontological concept of being: "phronēsis embraces the deep continuity between embodied action, imagination, and thought; between movement, empathy, affectivity, feeling and motivation, and how we frame the world in rational and ethical terms... It enables "knowing how to negotiate our way through a world that is not fixed and pregiven but that is continually shaped by the types of actions in which we engage"". (Van der Schyff, Schiavio, Elliott, 2023) In the preliminary review, learning was approached through error-correction, motor adaptation in learning, the role of long-term process, and the concept of emergent timing and flow. Overall, in studies considering embodied cognition, the influence of unconscious patterns and habits on learning seems to be emphasized because they are usually embodied. All studies reflect the role of embodiment in learning environment, and its role from the perspective of developing a healthier environment which could be useful to consider because the mentioned perspectives aim to clarify the forces affecting learning and knowing while taking self-regulation into consideration. Questions emerged in the included studies considering how directing, broadening or limiting attentional focus to internal sensations or body parts, movement or other senses, motion cues or environmental aspects helps in creating healthy movement and a motivating environment as well as questions considering the ways to exploit the relation of cognition to musical aspects, dynamical environment or embodied internal representations are relevant for preventive pedagogy. According to Schyff, Schiavio and Elliott (2023) examining forces that shape identity and consciousness and what it means to be and become a learner and teacher deserves insufficient amount of attention in enactive teaching. The embodied nature of natural behavior of human and its knowledge, which is emphasized in philosophical and clinical studies, can also be useful for the development of the practical area of teaching and learning, as well as preventive movement architecture.

### 3.2.2 Environment in Cognitive Strategies

The role of environment in cognitive strategies can be seen in many ways in the included studies, such as in the processing of conscious attention directed to the

environment or bodily sensations in relation to the environment, such as in relation to proprioception and exteroception, and in the processing of unconscious attention that can be guided by the teacher, which is related to cognitive load theory and exploiting gestures in different ways. Related to this theme, embodiment can be seen in questions according to interactivity while considering the relationship with the instrument, the structural parameters of music or the help of technology, as well as in relation to questions related to development, growth and age-specificity, and thus to psychological, social and socio-cultural questions, as well as to the interactive elements of somatic and enactive methods and the role of the teacher in preventive teaching. It is worth noting that the emphasis on interactional active involvement is emphasized in the included studies even in those that do not specifically consider aspects of embodied cognition. As mentioned above, the emphasis on understanding, attention and decision-making varies according to what kind of attention control or language use is seen to be beneficial for learning in the included studies. The processing of attention, which refers to the utilization of the environment, emphasizes concepts such as proprioception and exteroception, and the emphasis on intuitive decision-making is referred for example to concepts like situation-specific alignment or situation-specific way of coping from the preliminary review. In a large part of those considering embodied cognition more closely, the focus is considered on the least amount of conscious control. According to Schyff, Schiavio and Elliott (2023), enactive pedagogy should better consider autopoiesis as a guiding principle and learning as a dynamic adaptive process taking place through a primordial embodied way of contextually situated knowing, as well as understand the forces shaping identity and consciousness and building teaching around phronētic practices. (Schyff, Schiavio and Elliott, 2023)

According to the preliminary review, concepts relating to the utilization of the learning environment were improvisational and informal musical learning, exogenous embodiment, sensorimotor exploration, human- and technology-centered methods (embodied interaction, virtual reality, videos, applications: tangibles, kinect/wii, embodied artifacts, biosensor, embodied games) , active object manipulation, gestures, imitation, visual stimulation, collaboration, emotional component of music education, interactive musical learning and enactive approaches. Regarding the emotional component of music education, the importance of relationality in teaching, situated learning, affective components of movement and cognitive processes in the organization of social interaction were discussed. The relationship of the included studies considering prevention and environment can be seen in a holistic perspective in relation to the body, the instrument, focusing attention and dynamic interactivity, considering it in relation to body awareness, and by considering age-specificity in relation to primary and secondary prevention. They discussed maladaptive behavior, need to control,

socially prescribed perfectionism and anticipatory anxiety in relation to the social environment, considering the role of the body in proprioception, and the idea of use of whole self and relation to gravity. The teacher's role is emphasized in them for instructing the direction of attentional focus and they used demonstrations and visual aids and body-oriented methods. (Davies, 2020; Kongpakpaisarn, 2020; Détári, Nilssen, 2022; Rader, 2023; Sabo, Comeau, Guptill, Dvorkin, Russell, 2023; Détári, 2023) The second category of research considered the importance of cooperation and interaction and how to see metaphors and metonymies related to space and as interactional resource. The teacher's role was built for guiding students to connect their movements to the structural and stylistic features of a piece for example, to meter and rhythm, melodic contour, form, dynamics, and the expressive qualities of music. In addition to that, the teachers utilize use of gesturing, primary knowledge and cognitive load theory. (Van der Schyff, Schiavio, Elliott, 2023; Massie-Laberge, 2019; Mierowsky, Marcus, Ayres, 2020; Stevanovic, 2021; Papazachariou-Christoforou, 2022)

In addition to technology- and human-centered methods, the methods presented in the preliminary were Dalcroze Eurhythmics, Orff Approach and Cohen Body-Mind Centering and Groningen Exercise. The methods of the included studies are Taubmann approach (Kongpakpaisarn, 2020; Sabo, Comeau, Guptill, Dvorkin, Russell, 2023), Laban's movement framework (Papazachariou-Christoforou, 2022), Timani approach (Détári, Nilssen, 2022), Body Mapping (Rader, 2023), Alexander technique (Davies, 2020). In addition, there were mentions of numerous piano pedagogy- related methods and Détári's (2023) mentions of Feldenkrais Method and Dispokinesis. Laban's movement framework was the only one of the methods from the second category, in which ontology, applications for enhanced pedagogy, mimicking gestures and cognitive load as well as metaphors and metonymies played the main role. (Van der Schyff, Schiavio, Elliott, 2016; Massie-Laberge, 2019; Mierowsky, Marcus, Ayres, 2020; Stevanovic, 2021) Generalizable methods related to prevention include the awareness of gaining global sense of release before moving to the exercises targeting fine motor control and attention to the motor output being extremely vulnerable to the psychological and emotional states by appearing both in the postural (antigravitational) muscles, which carry the static load and in muscles contributing to the movement. In other words, the musician's mental state cannot be separated from somatic learning. (Détári, 2023) The effort to understand the psychological and emotional factors related to the performance of musicians in relation to music and movement can be related to the examination of effective or Instrumental gestures which are responsible for the direct control of the quality of the sound and changes applied to the instrument or ancillary or sound- accompanying gestures which are not necessarily related to sound production and are mainly the result of ergonomic, structural or

interpretative factors. Examining gestures in relation to the use of time and the coarticulated and compensatory features of movement offers perspectives on the effects of the musician's mental state. (Massie-Laberge, 2019)

In order to address forces shaping identity and consciousness, Van der Schyff, Schiavio and Elliott (2023) present Kincheloe's ideas to ground the case as follows: "...to move beyond mechanistic metaphors of selfhood, to appreciate the autopoietic (self-producing) aspect of the "self" in order to gain a more sophisticated capacity to reshape our lives… to understand the importance of socio-historical consciousness concerning the production of self… to recognize dominant power's complicity in self-production vis-à-vis ideologies, discourses, and linguistics… to conceptualize new ways of analyzing experience and apply it to the reconstruction of selfhood… to move schools to examine the ontological realm of self-production and the Myriad of forces that affect it… to become cognizant of the Cognitive act as the basic activity of living systems—the process of establishing relationships and new modes of being… to grasp the notion that this ontological process of cognition constructs the world rather than reflecting an external world already in existence… to realize that the nature of this world, the meanings we make about it, andour relationships with it are never final—thus, humans are always in process… to see that the self is not pre-formed as it enters the world—that it emerges in its relationships to other selves and other things in the world... to realize that the nature of the interactions in which the self engages actually changes the structure of the mind..." (Van der Schyff, Schiavio and Elliott, 2023). According to my opinion, the ideas reflect the objectives from the included studies in relation to the need to understand the dynamic nature of the learning environment and through the holistic aspects related to learning environment and combine both categories and could serve as a basis for developing preventive pedagogy. On a practical level, regarding embodied cognition- informed studies, it could be discussed about how cognitive load theory could be applied to preventive practice or perhaps discussing the use of metaphors and metonymies to give the teacher ways to better evaluate the student's disadvantageous postures. (Mierowsky, Marcus, Ayres, 2020; Stevanovic, 2021)

The role of music was seen as a tool in the studies using healthy movement and cognitive strategies by using music melody as an aid for understanding and interpreting the musical structure, studying how the dynamic shape, melodic and rhythmic patterns of music affect movement or its experience, or discussed the connection of movement related to structural and stylistic features of the peace. Based on the perspectives, the research could be continued, examining what kind of interpretation increase the risk for musculoskeletal problems and how the structural features of music can be

compared to intuitive knowledge and ergonomics. In addition, considering the embodied relation to the instrument, for example through internal representations and imaginary, could be useful from the view of preventive teaching. The movement architectures of the methods from included studies considered concepts such as coordination in relation to minimum effort, acquisition of knowledge of anatomy, gravity, breathing exercises, getting to know natural movement learned during developmental stages, brain-body-connection, awareness-related aspects , global sense or understanding the size, structure, and function of the body in parts and as a whole through the student's senses, movement, and attention and also around time-, space-, weight- or flow-related aspects for movement. (Davies, 2020; Kongpakpaisarn, 2020; Sabo, Comeau, Guptill, Dvorkin, Russell, 2023; Détári, Nilssen, 2022; Rader, 2023; Papazachariou-Christoforou, 2022) Among the methods, the Laban movement framework presented by Papazachariou-Christoforou (2022) stands out because it utilizes music as a close part of the cognitive strategy. The teacher's ways of utilizing the environment more precisely in cognitive strategies were reflected in external cues, which the student reaches for without consciously directing attention, such as the teacher's gestures, instructions for directing attention in reducing cognitive load, instructions for gesturing or the use of space and metaphors in language use. I wonder whether embodied cognition-informed studies could bring added value to aspects of somatic methods, for example by including more music, environment and embodied language in cognitive strategies.

# 4 DISCUSSION

## 4.1 Embodied Cognition in Preventive Pedagogy

The objective of the thesis was to combine theoretical and practical research, to bring sensory and cognitive aspects together with physiological strategies and try to understand how they can be related and how the many dimensions of growth and development affect to the development of musculoskeletal problems as well as to find out how the synthesis could create the groundwork or practical themes for more comprehensive health- and risk-aware teaching. In addition, the goal was to outline the reasons why this comprehensiveness is necessary. The goal was to find out whether embodied cognition is a valuable tool for development of preventive pedagogy. There is an overlap between the results of the preliminary review and the synthesis, as well as the studies of both categories, and this represents a possible useful role of embodied cognition in prevention of musician's musculoskeletal problems in the learning environment. Various musculoskeletal problems develop due to several different reasons and holistic thinking could be useful in the teaching environment. The perspectives brought by the synthesis for embodiment, what it is to be and to know in the learning environment creates a foundation for a more holistic teaching. I see that if something can be justified as an activity that supports development and health, it can also contribute to the prevention of some specific problems, even if it is difficult to demonstrate. Demonstrating cause-and-effect relationships is challenging, and for this reason, looking at a broad perspective from different aspects can give teachers the tools to come up with creative solutions according to their own assessment and the needs of the students. The included studies considered the main topics from symptom or disease-specific, instrument-specific or method-specific view, but studies from a broader perspective concerning all musicians and the theory of embodied cognition,

combining embodied cognition, prevention of musician's musculoskeletal problems and music pedagogy, were not found through the search. Taking it to consideration I included the studies which were somewhat related to the topics that could possibly create a basis for the research according to the initial topic criteria with the help of synthesis.

Based on the synthesis, many studies emphasized a holistic perspective in learning in different ways, where developing a sense of embodied self-awareness and open mind to explore possibilities in terms of movement are emphasized. In relation to attentional control, the justification for comprehensiveness is that many aspects or set of tasks related to learning are impossible to control in parts. With Rader (2023), the whole can be seen in a thematic analysis, which was built around cognitive (understanding and awareness), physical (re-mapping process), and emotional (state-of-mind) processes. Comprehensiveness can also be seen when combining breathing, interpretation and health related aspects. (Rader, 2023) As shown in Détári and Nilssen's (2022) study, excessive focus on postural corrections affects losing sight of performance as the goal of coordination and separated them from expression, and the study mentions the need for a better understanding of dynamic performance context. (Détári and Nilssen, 2022) I see that equally focusing only on proprioceptive or exteroceptive input in learning can cause a similar loss of perspective, and I see that in part Rader's (2023) perspective on interoception stems from this need and taking it into account in preventive teaching can be useful. In my opinion, the embodied cognition research program can offer a deeper understanding of the mentioned needs, because it aims to understand dynamic context and sees the themes mentioned by Rader as more closely related. The human has the tendency to automate also the wrong kind of movements and embodied patterns and I see that embodied cognition can give more understanding for understanding these automatic processes. In addition, the research program offers ways for utilizing the environment in cognitive strategies in many ways, and they could be added to the teachers' procedure in addition to knowledge related to somatic and attention control, which partly makes the teacher's work more comprehensive.

While examining the connection between healthy movement and interpretation, Massie-Laberge (2019) offers an insight into musician’s movements providing intuitive information about what kind of movement supports ergonomics and makes movement instinctive, and how the structural features of music can be better considered from an ergonomic point of view, as well as what kind of interpretation increases the risk of musculoskeletal problems, considering for example duration and flow of performance. It was also noticeable that movements seemed to be localized to certain body parts and their amplitude were reduced during technically challenging passages

and this could potentially prevent injuries. The results of Massie-Laberge (2019) also show how immobile condition was found to be easier to implement than exaggerated or how deadpan affected for example to their sense of phrasing, tempo and dynamics. The research opened both how harmonic tension and acoustic features can affect movements. Massie-Laberge's research also describes how, in some cases, mental representations were so deeply entrenched that their conscious reduction or elimination was not possible. (Massie-Laberge, 2019) All the examples describe instinctive and embodied cognition in different ways, which is useful information for the teacher, for example, in terms of how encouraging exaggeration at the expense of healthy movement can be treated with caution. The goal of instinct is justified from a health point of view, if it presumably causes less cognitive load and therefore enables concentration on interpretive factors. In connection with the treatment of interpretation and healthy movement, I think we could also look at the possibilities of cognitive load theory, which appeared in the second category of studies to understand interpretation more broadly as part of the environment, and the utilization of primary knowledge and the possibilities of the theory from the point of view of interpretation or task-specific awareness.

The results of the synthesis challenges my hypothesis regarding the fact that with an integrative review I cannot prove the causal consequences of whether embodied cognition-informed views are worthwhile for prevention and therefore causal consequences can be studied better with other types of research methods. It would be appropriate to be critical how embodied strategies are used in teaching and where the focus of teaching should stand. The prominence of the topic, especially in recent dissertations, and the overlap of the topic at least on the meta level is noticeable in both categories and it can imply it being worthy for considering. According to my opinion, the most important observations are a more precise awareness regarding questions about the amount of necessary attention control, the use of the senses and environmental cues, and several follow-up questions related to my subject area that arose as a result of the thesis. Based on the preliminary review, one can further consider the role of embodied cognition in the prevention of clinical studies or specific musculoskeletal diseases, as well as in relation to organic and non-organic problems, in questions related to the use and perception of time, and in understanding individual needs, for example, in contexts connected to focusing attention. In addition, we can consider how the embodied cognition view helps to develop an understanding of internal reasons and to develop self-regulation-related aspects of preventive learning also in the early stages of growing up. In addition, embodied cognition perspectives can offer ideas for intuitive reasoning and exercises related to primary or unconscious activity and awareness of in what kind of situations they are relevant. It is useful to consider

how these perspectives or questions can be applied in general in teaching if no specific embodied method is used and also how they can be applied specifically to specific phases of learning or motor development. It is also possible to consider how the development of practice and the consideration of enactive ontology in teaching guides the understanding of the meaning of being, movement and motivation to move.

The studies provided valuable information and concepts as a basis for preventive pedagogy. Consensus was emphasized regarding the need for comprehensiveness and addressed the body's role in cognitive activities in several ways. The embodied cognition perspective encourages deeper empirical and ontological understanding of the relationship of psychological, social and emotional aspects to movement and somatic learning. Based on the synthesis, preventive pedagogy exercises could be built on the basis of holistic nature of philosophical and practical basis, active participation and the embodied elements of cognitive functions, comprehensive motor alignment, understanding the learner through embodied self-regulation- related aspects and as part of the environment helping the student with cognitive strategies that utilize exogenous and endogenous attention, implicit memory, attentional control and movement senses. The strategy can consider the interaction between movement and cognition, the use of embodied internal representations, music cognition and the importance of interpretation, music and body language in relation to the development or prevention of musculoskeletal problems. In addition, the strategy can utilize gestural knowledge, cognitive load theory, technology supporting embodiment, development-growth and age-specific embodied perspectives and develop knowledge of various enactive and somatic methods. Rader (2023) brought up the perspective of prioritizing identifying ways to make prevention education the norm for all groups of musicians. (Rader, 2023) According to my evaluation research is going to that direction, and the focus seems to be moving closer to the importance of experientiality in learning and health. The importance of the experience can be seen on a practical level in diverse ways of embodied cue integration, which can be an important factor in increasing motivation, creating meaning, reducing cognitive load, and freeing up focus on the world of music and images. Preventive learning would consist of ways of utilizing awareness to support healthy growth and learning, directing attention control and supporting adaptation for finding embodied cues, support self-regulation and trusting intuitive reasoning.

When examining the most significant themes of the preliminary reference framework, through synthesis, the reference framework can be developed to consider aspects related to cognitive functioning in all themes in diverse ways. In relation to the role of movement and ergonomics factors in relation to playing-related factors and numerous mentioned aspects and risk factors related to prevention (physical health indicators,

neutral posture, accumulation of physical and postural stress, strain, importance of strength, upper extremities, ergonomic optimization [optimal instrument condition, biomechanical training, sitting position, lightning, chinrest type, acoustic factors], awkward posture, too isotonic and isometric movements, too early and repeated use of a technique requiring relaxation and fluency, Sudden increase of training time, ease, natural movement , elevated arm position, flexor muscle behavior, excessive incorrect repetition, postural stress ; 1.2.1.3), could considered especially in relation to the perspectives of synthesis according to possibilities related to movement and cognition. The effects of imagery for conducting the above-mentioned movements by examining the relationship of the movement to internal sensations or by combining imagery with movement exercises or conducting movement with specific imagery could be considered. Also the effects of movement on the interpretation in which the above-mentioned behaviors occur could be considered. In addition, examining what kind of information the body or movement can produce or store that would benefit ergonomic behaviors could be useful. Also discussing of influencing cognitive functions with special movements, for example in relation to gestures or thinking with gestures, and considering what kind of gestures help in planning healthy movement or, similarly, considering the effects of cognition on movement, for example with motor simulation could be useful. Based on the mentioned aspects, targeted movement exercises can be developed by directing attentional focus to global control or a specific movement or part of the body. Sabo's (2023) mention considering potential biomechanical inaccuracy of metaphorical language, could be developed by considering the development of language by increasing the number of different movement containing gestures. Of which aspects are special about the physical requirements of musicians, for example in relation to fine motor skills could be part of the discussion of musician's movement and ergonomics.

Relaxation plays an important role in psychosomatic development, and on that account in the preliminary review it took shape of its own section. Related to aspects related to relaxation (practice time, breaks [of 10 to 15 minutes should be taken every 30 to 60 minutes during practice], Absolute rest, farming up, warm-up exercises, physical and musical exercises, abrupts increase in practice time, years experience exertion after 45 min without breaks), I outlined how visual stimulation, thinking with gestures and embodied simulation could be part of relaxing practices. During the synthesis, the relaxation-related topic developed in a direction where the warm-up exercises could be considered through exercises related to primary prevention. In my opinion, the application of the exercises could also be considered in terms of secondary prevention for the warm-ups and cool-downs without or with a musical instrument. According to Rader (2023) secondary prevention includes warm-ups or cool-downs

before and after playing, breaks during playing periods, exercise, general health information, or other types of body or movement awareness, while primary prevention focuses directly on the teaching situation. (Rader, 2023) The role of factors related to growth and development (cognitive development, the effects of growth on muscle development... subjective factors, age, disabilities, first- or second-year Master's student, accumulative physical stress, grade (lower graders had more discomfort related to higher grades; 1.2.1.3) could also be taken into account while planning the exercises. In addition, various affective aspects underlying somaticity were considered (psychosocial stress, psychosocial factors, stress related to playing instrument, string class frequency, social factors, mental health indicators, high somatization, fear of a career-ending disability, temporomandibular disorder (TMD) related to musician's performance-anxiety (MPA), targeted interventions; 1.2.1.3), which affect muscle tension, which were identified through synthesis with more emphasis on interactivity.

In the section regarding aspects of cognitive functioning (body awareness, attitude towards pain [Some Musicians accept musculoskeletal pain as a normal and necessary], understanding the use of force, metacognitive thinking, enjoyment of music, concept of balance ; 1.2.1.3) a more diverse point of view was considered concerning practices during the synthesis, related to focus and control and being aware of different options related to it and, also related to the development of movement architecture and relaxing exercises. The importance of music in this equation, how in a musical experience, including expressivity and emotional components, the body not only shape the perception, but its participation in the activity shapes the way of thinking could be considered. Several enactive and somatic methods and techniques were identified partly as aspects of the topic, such as Dalcroze Eurhythmics, Orff Approach, Cohen Body-Mind Centering, Alexsander technique and Feldenkrais method, Taubmann approach Laban's movement framework Timani approach, Body Mapping, Dispokinesis, Groningen exercise, and related to the piano Ortmann's The Physiological Mechanics of Piano Technique, The Lister-Sink Method, Sándor's Technique, Alan Fraser's Technique. In addition to those mentioned, the need for various prevention programs, prevention and treatment strategies and primary and secondary prevention were identified. In their implementation, one can evaluate the possibilities of technology-centered methods such as embodied interaction, virtual reality, videos, applications: tangibles, kinect/wii, embodied artifacts, biosensor, embodied games and interactive musical learning. Traditionally learning musical instrument is not seen at least primarily as promoting physiological health and preventive activity, but mainly from the perspective of mental well-being. It might be useful if teachers familiarized themselves with these different options, studying the relationship between somatic methods and embodied cognition and evaluate the possibilities for reaching the initial

role of the individual relation to their environment and to support development in a natural, inspiring way and by recognizing embodied challenges and motivators related to learning.

## 4.2 Limitations

This thesis has potential limitations related to methodological factors, subject and overall picture that impact the interpretation of the results. The integrative review method has been criticized due to the possibility of bias and lack of discipline (Toronto and Remington, 2020). There were a few factors involved in combining the thesis and the integrative review method, which influenced the systematic progress of the integrative review. The way in which I have collected information may have limited my ability to analyze the results thoroughly, for example, in all integrative reviews there is no predetermined theory or parts of the subject area or a preliminary review that would partially guide the direction of the research. The effort to limit the number of pages contributed to the thoroughness. On the other hand, I followed the structure required by the thesis and tried to combine the method and the structure of the thesis. According to comprehensive journal article of Hecker and Kalpokas (2024) the challenges of thematic analysis can be related to dependence on subjective interpretation, the challenge of holding analytical rigor, data overload, strategies in validating the findings. The mentioned factors can cause limitations for research. (atlasti.com, 2024) According to Stewart (2024) constant comparison method is fluid and adaptable and knowledge arises directly from the data and the realities it creates (atlasti.com, .2024) A possible limitation related to the analysis method may be related to whether the researcher remains flexible and allowing information to emerge organically from the data. Integrative reviews are highlighted in clinical studies related to evidence-based practice (EBP) and according to my observation, the method is used less often in research in the humanities field, and I experienced some challenges connecting them.

According to Haevert (2017), limitations related to content analysis can be the following:"… (a) that the approach is inherently reductive and tends to diminish complexity and context; (b) that the approach is unlikely to preserve the interpretive properties that underlie the included qualitative evidence; (c) that content analysis may fail to reflect the structure or importance of the underlying phenomenon; (d) that the approach could treat the absence of evidence (i.e., nonreporting of evidence by primary-

level authors) as evidence of absence (i.e., findings that are not important); and (e) that content analysis results may be oversimplified and review authors using content analysis may be tempted to count only what is easy to classify and count rather than what is truly important (Dixon-Woods et al., 2005)." (Haevert, 2017) According to Haevert (2017) critical interpretive analysis has also potential limitations: "An issue with the critical interpretive synthesis approach is that it remains unclear how exactly the qualitative, quantitative, and mixed evidence is integrated. For instance, the Dixon-Woods, Bonas, et al. (2006) critical interpretive synthesis on access to health care by socioeconomically disadvantaged people in the United Kingdom included 119 papers. However, it is not clear what the proportion of qualitative, quantitative, and mixed primary studies included in the synthesis was; which types of studies or designs were included; what the contribution of the retrieved qualitative, quantitative, and mixed data to the end product of the critical interpretive synthesis was; and how exactly the qualitative, quantitative, and mixed evidence was integrated. (Haevert, 2017)

There are some restrictions on keywords. Possibly, the search vocabulary related to the topic could have included some other terminology related to the theory of embodied cognition. According to my evaluation even a narrower search vocabulary could have led to results with a wider perspective, and since it is difficult to prove the uniqueness of the search vocabulary and it affects the generalizability of the results. On the other hand, it wasn't meaningful for taking the risk of narrowing down the topic, because according to the preliminary review, it seemed the thesis part of the topic emerged at the meta level in various studies and the desired variation between the research topics could also have been too narrow. In the future, with the clarification of the parts of the whole, a narrowed perspective can also give more profound answers in terms of the whole. When the terminology around the topic is not universally recognizable, even the terms used, such as the umbrella term embodied cognition, can have different results than using, for example, the terms found under it. In the future, it could be relevant to conduct a similar study with the terminology related to the topic, which this study tried to identify. Lack of previous research studies on the topic is a limitation in itself, which is also partly the result of this study, at least as it is and with these search terms, but the results may vary if the search terms were more specific. On the other hand, discovering a limitation can be considered an opportunity to identify gaps in research literature and to present needs for the further development in the area of study. Lack of previous studies made it difficult to come up with the best ways to proceed according to the method, the implementation of which usually uses data that is already abundant. Based on the results, the research could be continued in order to find clearer theoretical and conceptual dimensions or

typologies about the connections between prevention and embodied cognition in learning environments.

The small number of included studies was chosen due to the limited schedule, and with this, the results can only be used as potentially indicative assessments or potentially functional further ideas for research and practice. Again, recognizing topic being fragmented and containing unclear terminology, increasing the amount of data would not necessarily have served stated objectives. The amount of time required by the method and the limiting the number of pages could also have contributed to the analysis of the study not reaching as in-depth aspects as it could have. However, understanding the overall picture of the subject was the main part. Integrative reviews are usually conducted with the help of many authors (Remington and Toronto, 2020). I discovered conducting the work alone within a limited time frame causing difficulties, and it could be a limitation for the thesis, making it difficult to reach the necessary depth during the analysis phase. Although based on the analysis it would have been possible to do an even more in-depth content analysis, which would have been meaningful in terms of the subject. However, the method of integrative review, which aims for an overall picture, does not require it in itself. The violin teacher's qualification and the musician's background may have guided for choosing subjects that feel intuitively clos, thus affecting the reflexivity of the thesis. However, I aimed to avoid biased views regarding my background and for this reason, among other things, I did not limit the research only to violin- related topics. In addition, the inclusion of a wider range of instruments turned out to be one of the gaps in the literature. I conducted the beginning of the analysis with the free version of NVivo and the end without any software's. The limited access caused my analysis a few difficulties, but in the end, I think they did not significantly affect the progress of the analysis.

## 4.3 Implications

My preliminary assumption regarding the low focus on the development stages of motor skills, multisensory development and playing-related problems in the learning environment being the long-term cause of musculoskeletal problems in musicians appeared in many ways in the topics of the included studies concerning practical ways to develop preventive teaching. The studies considered early education and the education of more advanced musician's regarding both primary and secondary prevention. It indicates that the subject areas are seen to some extent as significant in

preventive education. My assumption, according to which embodied cognition could enable the understanding of the cause-and-effect relationships of musculoskeletal problems, appeared in studies considering several dimensions in the background of somatic functioning and the effects of environmental factors. I see that the subject area has value in transferability, regarding social meanings related to movement and multidisciplinary applications. According to practical implications for the music industry, the synthesis may serve potential basis ideas for preventive pedagogy, organizations or other education that utilizes health-related and evidence-based health advice. The long-term effects of possible outcomes may be reflected in socially reduced sick leave and increased well-being. The synthesis method of critical interpretation aims to dismantle research traditions and theoretical assumptions, and in an integrative review a new kind of overall picture is created. In this work, the overall picture took shape around acknowledging the nature of embodied human activity and cognitive strategies in movement architecture development. A gap in the literature regarding reviews and a general perspective regarding embodied cognition and prevention was noticeable, and therefore the effort was to develop the research tradition and the importance of integrative reviews in well-being research.

From the point of view of teaching practice, the synthesis provided evidence for a critical examination of traditional teaching, which was also cited in other studies. In the case of teaching methods, the connection to aspects of embodied cognition could be seen in the conceptual ambiguity and the lack of a theoretical basis. In addition, a gap in the integration of health research and the creative field in creating a general framework that would help teachers to consider the factors affecting the health of musicians through creative activity was noticeable. Research frameworks and methods could be developed to consider the mentioned connection, in order to obtain a more reliable and systematically produced result from the research. Perhaps the created framework can also help to plan teaching interventions or short trainings for teachers or short training from teachers to students, by focusing on a certain area of preventive teaching or include versatile cognitive movement strategies. In the synthesis, there was a mention of how to conduct science based on pedagogical knowledge. In my opinion, there is a need for translating scientific knowledge into pedagogical language. In the future, my topic regarding a broad perspective could also focus on instrument- or instrument-group-specific prevention in teaching. In addition, since the prevalence of piano pedagogy in the area of preventive research was noticeable, research could also be developed for other musical instruments. In addition to that, as it was stated that embodied cognition is a potentially misleading term, being an umbrella concept and also the name of research program, the research could be limited to more specific research trends or theoretical perspectives of the research program. The possibility of

prospective studies related to the subject area could also be considered in future research. As far as clinical preventive teaching studies are concerned, the focus seems to be on the functioning of the senses and less on the utilization of internal representations. I wonder whether the role of the internal representations and gestures could be assessed in clinical studies. Future research should empirically demonstrate whether the aspects of embodied cognition as part of preventive education support motor development and the prevention of musculoskeletal problems.

Childhood physical education generally receives more state aid and has a better societal cultural position. The teaching environment in movement and music education is also very different from time-related and interactive perspectives, which should be considered also in terms of distance learning opportunities. I have been acquainted with the extent of musician's musculoskeletal problems. There has been a lot of research and discussion about recovery and music-related treatments and the focus on primary prevention and long-term importance has remained less considered. Due to the societal cultural status of music and the current uncertain state of the world, music teachers could benefit from the creative applications of interdisciplinary health-related knowledge. Interdisciplinary embodied research literature could provide perspectives for the development of preventive instrument pedagogy and later increase the value of music for public health. In my opinion, research in the subject area could also be applied to social perspectives such as inclusiveness and the public health perspective. In addition, the benefits of some applications related to attention problems could be considered. Also, the requirements of adaptive expertise, where teachers are required to be skilled in a rapidly changing culture regarding, for example, regional development, is a topic that could benefit from research examining embodiment and its role in the learning environment. Future research could also be limited to specific dimensions of growth and development that preventive research identifies. From a broader perspective, technological and clinical multidisciplinary applications could also be discussed. Also, for example, bioethical questions in the field of embodied cognition in connection with the development of robotics and artificial intelligence may concern aspects of my topic. And since the thesis topic mainly concerned non-organic factors of musculoskeletal problems, also the perspective of organic problems of musculoskeletal problems related to embodied cognition-informed clinical research could be significant, so that living under the influence of organic factors could be better understood and developed for better well-being.

# 5 CONCLUSIONS

The thesis explores the story behind the thematic synthesis and is addressed to various professionals in the music field. The thesis conducts interdisciplinary basis of ideas for preventive education and future applications around music field while recognizing meaning of the confluence of holistic health and instrument teaching environment. Considering the confluence may grow curiosity towards the benefits of interdisciplinary practice and review studies as well as the benefits of music culture for public health resulting possibly by increasing motivation of the students and general acknowledgement of more diverse ways of moving. A gap in the literature concerning embodied cognition and the prevention of musician's musculoskeletal problems were identified, and based on the emerged themes of the synthesis, further research seems necessary. Resulting of the synthesis consistent themes around the field of embodied prevention can be found and refined with further studies. The most important observation regarding the thesis is acknowledgement of the diverse possibilities of holistic teaching practice promoting music research considering questions about well-being and effects of developmental stages and above all by recognizing the embodied and primary nature of human activity.

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