TEACHING JUDO EFFICIENTLY

Applied nonlinear pedagogy

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ABSTRACT

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Research in motor learning has advanced immensely over the last two decades, but there is relatively little transfer to pedagogy (Chow 2010). Nonlinear models of learning have been proposed to be more effective than traditional linear models of learning (Lee et al. 2014; Gray 2018; Nathan, Salimin & Shahril 2017). However, combat sports and self-defense are still often taught according to a traditional model by having students emulate a movement pattern demonstrated by an expert (Körner & Staller 2017).

This study aims to bridge that gap for judo by answering two fundamental questions: How can judo be taught using nonlinear pedagogy and what kind of principles practitioners can use to help them apply nonlinear pedagogy in teaching judo.

To answer the questions, a training program consisting of twenty 60-minute training sessions was created to teach various aspects (e.g. techniques and tactics) of judo according to nonlinear pedagogy. An intervention was then conducted where an advanced group of fifteen judokas was taught according to that program. The group consisted of 13 men and two women and on average the participants had practiced judo for 14 years before the intervention. The training sessions were coached and observed by the author of the study. The observation was conducted using participant observation (Tuomi & Sarajärvi 2018, 70; Vilkka 2018).

As the result of the study, the observations were synthesized with theoretical knowledge to create six principles to help practitioners utilize nonlinear pedagogy in their coaching. The principles were: 1. Teach how a technique works – not how it's done, 2. Train like you fight, 3. Simplification – controlling the tactical complexity of judo, 4. Individualization: same technique – various difficulties, 5. Teach gripping as a system and 6. Encourage problem solving by asking questions.

In this study nonlinear pedagogy was found to be a suitable method for teaching judo and its key principles were adapted to a judo-specific form to act as a practical tool for coaches and teachers. This study provides insight into how judo could be taught using nonlinear pedagogy, but further research is needed to study its effects and compare it to a more traditional approach to provide justification for a shift in teaching paradigm.

Key words: nonlinear pedagogy, judo, motor skill, skill acquisition

TIIVISTELMÄ

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Motorisen oppimisen tutkimus on edistynyt merkittävästi viimeisen kahden vuosikymmenen aikana, mutta tutkimustieto ei ole juurikaan siirtynyt pedagogiikan puolelle (Chow 2010). Nonlineaaristen oppimismallien on esitetty olevan perinteisiä, lineaarisia, malleja tehokkaampia (Lee et al. 2014; Gray 2018; Nathan, Salimin & Shahril 2017). Kuitenkin kamppailulajeja ja itsepuolustusta opetetaan edelleen usein perinteisen mallin mukaan, missä oppijat jäljittelevät edistyneen harrastajan näyttämää esimerkkisuoritusta (Körner & Staller 2017).

Tämä tutkimus pyrkii kuromaan umpeen tuota motorisen oppimisen tutkimuksen ja pedagogiikan välistä kuilua judon osalta vastaamalla kahteen perustavanlaatuiseen kysymykseen: Miten judoa voidaan opettaa käyttämällä nonlineaarista pedagogiikkaa ja minkälaisia periaatteita valmentajat ja opettajat voivat käyttää apuna nonlineaarisen pedagogiikan soveltamisessa judon opettamiseen.

Vastatakseen tutkimuskysymyksiin, luotiin tutkimuksessa harjoitusohjelma, joka koostui kahdestakymmenestä 60 minuutin harjoituksesta, judon eri osa-alueiden (esim. tekniikoiden ja taktiikan) opettamiseen nonlineaarisen pedagogiikan mukaan. Sen jälkeen toteutettiin interventio, jossa edistyneistä judokoista koostuvaa, 15 harrastajan ryhmää opetettiin sillä ohjelmalla. Ryhmä koostui 13 miehestä ja kahdesta naisesta ja keskimäärin osallistujat olivat harrastaneet judoa 14 vuotta ennen interventiota. Harjoitukset ohjasi ja havainnoinnin suoritti tutkimuksen tekijä. Havainnointimenetelmänä käytettiin osallistuvaa havainnointia (Tuomi & Sarajärvi 2018, 70; Vilkka 2018).

Tutkimuksen tuloksena havaintojen ja teoreettisen tiedon perusteella luotiin kuusi periaatetta helpottamaan nonlineaarisen pedagogiikan hyödyntämistä judon opettamisessa. Periaatteet olivat: 1. Opeta miten tekniikka toimii – ei miten se tehdään, 2. Harjoittele niin kuin ottelet – edustavat harjoitteet, 3. Yksinkertaistaminen – judon taktisen monimutkaisuuden hallinta, 4. Yksilöllistäminen: sama tekniikka – vaihtelevat vaikeustasot, 5. Opeta otteenhaku järjestelmänä ja 6. Kannusta ongelmanratkaisuun kysymällä kysymyksiä.

Tässä tutkimuksessa nonlineaarisen pedagogiikan havaittiin olevan sopiva menetelmä judon opettamiseen ja sen perusperiaatteita sovellettiin erityisesti judon opettamiseen sopivaan muotoon, jotta voitiin tarjota käytännöllinen työkalu valmentajille ja opettajille. Tämä tutkimus tarjoaa tietoa siitä, miten judoa voidaan opettaa hyödyntäen nonlineaarista pedagogiikkaa, mutta lisätutkimusta kaivataan sen vaikutusten selvittämisessä. Erityisesti nonlineaarisen pedagogiikan ja perinteisen opetusmenetelmän vertailua kaivataan, jotta voidaan perustella mahdollista opetusmetodin muutosta.

Asiasanat: nonlineaarinen pedagogiikka, judo, motorinen taito, taidon oppiminen

CONTENTS

1 INTRODUCTION

Motor skill acquisition has been studied extensively since the middle of the nineteenth century (Anson, Elliot & Davids 2005) and there have been significant advances. Current research supports a constraints-led approach (Davids, Button & Bennet 2008) to explain the process of motor skill acquisition. Nonlinear pedagogy (NLP) is a model for teaching that is based on the constraints-led model of skill acquisition. It has been found to be an effective method of teaching motor skills (Lee et al. 2014; Gray 2018; Nathan et al. 2017). However, there is very little research on its application in combat sports. This study aims bridge that gap by studying the application of NLP in judo.

Pohja (2019, 5) argues that a central problem in Finnish judo is the lack of a comprehensive understanding of the concept of fighting skill. In light of current theoretical knowledge on skill acquisition (see Chow, Davids, Button & Renshaw 2016; Davids et al. 2008), it seems that judo might benefit from a thorough reform of the way it is trained. A traditional model of training judo involves countless repetitions of techniques performed in a prescribed manner against a passive or even a co-operating partner (Pohja 2019, 71). Despite mounting evidence to support them, nonlinear teaching methods are not widely used in judo, or other combat sports for that matter.

In order for coaches and teachers to adopt a new approach to teaching motor skills, it is important to provide them with support and resources to facilitate the transition (Chow et al. 2016, 141). This study aims to aid in that process by introducing practical principles for coaches on how to apply the scientific knowledge on skill acquisition to their work in teaching judo.

To accomplish that, an intervention was conducted, where an advanced judo group was coached according to nonlinear pedagogy (NLP). The training program was created based on the theory of NLP and the training sessions were observed. Those observations were analyzed, and the results were synthesized with the theoretical framework of NLP and the scientific knowledge on judo to create six principles for teaching judo. In those principles, the current scientific knowledge of skill acquisition is condensed and presented from a judo-specific point of view. Their objective is to act as a practical and easy-to-use tool for coaches to start adopting a new paradigm for teaching skill.

The first three chapters in this study present the theoretical framework of NLP to offer insight into skill acquisition. The fourth chapter then examines judo from the point of view of NLP and skill acquisition to gain a better understanding of the fighting skill that Pohja (2019, 5) calls for. The principles are presented as the result of this study in chapter seven.

2 THE THEORETICAL BASIS OF NONLINEAR PEDAGOGY

Nonlinear pedagogy (later NLP) is a method for teaching motor skills that presents coaches and teachers, and other personnel in the profession of teaching motor skills (later referred to as practitioners), with information and ideas on how to organize and structure practices to optimize skill acquisition (Chow et al. 2013). A key aspect of NLP is that it is firmly based on scientific, as opposed to experiential, knowledge and to understand its pedagogical principles it is crucial to understand that theoretical basis.

The primary theory behind nonlinear pedagogy is the constraints-led approach to skill acquisition (later CLA), which in turn is underpinned by two distinct theories: the dynamical systems theory (Bernstein 1967; Clarke & Crossland 1985) and ecological psychology (Gibson 1979). CLA offers a theoretical framework that explains how movement coordination emerges through person-environment dynamics (Chow et al. 2016, 51) and aims to describe how skill acquisition is predicated on interacting constraints in sport (Chow et al. 2009).

2.1 Constraints on human coordination

Coordination is a term often used loosely in daily life, but from a skill acquisition perspective its meaning is relatively well specified (Chow et al. 2016, 8). Turvey (1990) aptly described movement coordination as the process where multiple neurobiological system components are organized properly in relation to each other during a goal-directed activity. The process of organization is considered to happen mostly without conscious control and dynamical systems theory is used to explain that process of self-organization.

The human body is a highly complex system, where all its parts constantly interact with and affect each other (Clarke & Crossland 1985, 16). If the action of one part is altered, it inevitably leads to alterations in the actions of the others. For example, when a driver looks over their shoulder when driving a car, the action most often happens without conscious control, they simply turn their head. However, the same process of turning one's gaze can also be accomplished with very little relative movement between the head and the shoulders. The different movement pattern becomes obvious when a driver suffers from severe neck pain. This time they might again start by turning their head but a jolt of pain probably leads to them keeping their neck stable and rotating their spine from a lower point. Thus again ending up

with their gaze where they want it, but with very different movement coordination i.e. the order in which the parts of their body have organized themselves.

The degrees of freedom problem. The question of how we select the movement from all the possibilities has become known as Bernstein's degrees of freedom (DOF) problem (Bernstein 1967; Davids et al. 2008). DOF are the parts that form a complex system and they can fit together in many different ways (Bernstein, 1967; Davids et al. 2008, 20). In the context of human motor behavior, the limbs, joints and muscles are considered to be degrees of freedom and their various states of organization, in the form of different postures and movements, are the end states that a performer reaches depending on the different constraints.

The question of how to decide which way to organize the DOF to reach the desired outcome is the key issue. Bernstein (1967) proposed the idea that initially when learning a new skill, the performer will form rigid links by stiffening most of their joints. Experts on the other hand can handle more DOF and incorporate them into a highly functioning, controllable unit. Bernstein's idea has been widely studied and found to be true in many sports, i.a. slalom skiing (Vereijken, van Emmerik, Whiting & Newell 1992) and pistol shooting (Ko, Han & Newell 2017).

Newell (1986) further refined Bernstein's (1967) idea by categorizing learning into three stages based on how the learners at each stage deal with the high number of DOF. Learners at the first stage (beginners) typically employ coordination solutions where they reduce the number of DOF by "freezing" most of them (Chow et al. 2016, 11; Vereijken et al. 1992). The solutions eases their burden by manipulating a lower number of DOF, but usually leads to rigid and awkward movement.

At the second stage of learning the previously frozen and constrained DOF are released and their involvement is increased, resulting in smoother movement (Chow et al. 2016, 11; Newell 1986). Chow et al. (2016, 11) describe learners at the last stage to be able to utilize the reactive forces from performer-environment interaction, such as friction and gravitational forces. According to them, that skillful exploitation of forces is what makes expert performance often seem effortless.

2.2 A constraints-led approach to skill acquisition

Davids et al. (2008, 82) define skill acquisition as a process where the learner, i.e. a dynamical movement system, searches for stable states of coordination, meaning that they try out different movement solutions, during goal directed activity. During that process the learner first specifies a task goal (what they want to accomplish) and then starts exploring different solutions, i.e. start practicing. That exploration then leads to the emergence of an approximate solution, the stiff and awkward movement of the first stage of learning mentioned earlier, that over time refines into a more and more effective solution.

Thelen and Smith (1994) and Davids et al. (2008, 83), among others, propose that the exploration happens in a perceptual-motor landscape. That landscape is seen to consist of various stable states of coordination (or movement patterns), that the learner must choose from and apply to perform techniques, i.e. the specific basic movements of different sports (Jaakkola 2010, 46) effectively. For a judo player the perceptual-motor landscape might include different ways of gripping the opponent, different ways of moving and throws etc.

Constraints are what shape that landscape (Chow et al. 2016, 51). They both limit and enable the various stable states of coordination that can emerge from the perceptual-motor landscape (Davids et al. 2008, 33). Newell (1986) divided constraints into three categories (performer, environment and task) and created a framework (see Figure 1) to explain how constraints affect the emergence of movement coordination in goal-directed activities.

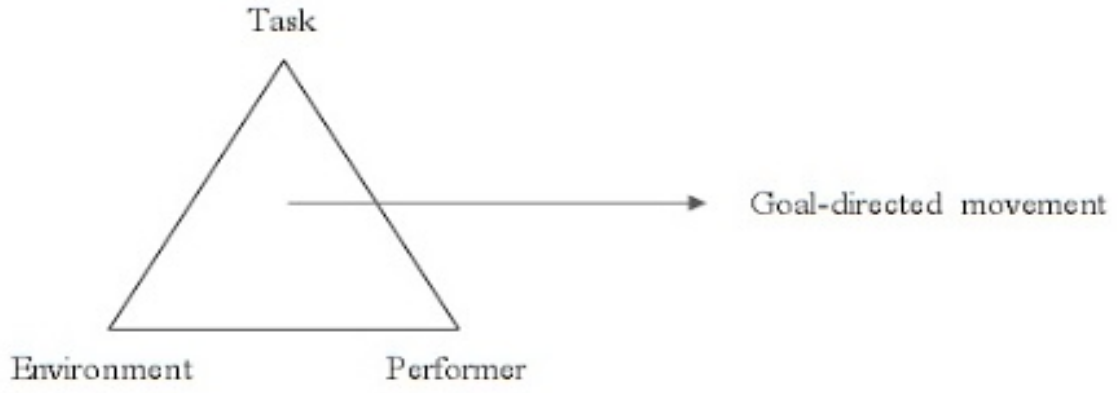

Figure 1. The emergence of movement coordination. Adapted from Newell (1986)

Newell's (1986) framework suggests that constraints channel the dynamic movement system, the learner, toward certain movement patterns. They set the boundaries for a given learning context that only allow specific movement patterns to emerge. For example, two judo players (judokas) will have different constraints in any given situation. Their skill, i.e. the ability to choose and perform appropriate techniques at the appropriate time (Jaakkola 2010, 46), physical attributes and favorite techniques will always impact their performance in any given situation, i.e. they act as constraints that shape the players' perceptual-motor landscape.

2.2.1 Performer constraints

Performer constraints are those features or characteristics that affect the physical or functional aspects of the performer and include such factors as height, weight, limb length, motivations and emotions (Chow et al. 2016, 53; Davids et al. 2008, 40; Renshaw, Chow, Davids & Hammond 2010). Examples of this can be found everywhere. Consider, for example, a person encountering stairs. If that person is physically fit and healthy, the stairs are probably no hindrance for them. However, for someone using a wheelchair those same stairs may prove an impassable obstacle. The same principle is true in a sport context. For example, a judoka who is tall and has long arms will probably have very different movement solutions to emerging situations than another one who is both short and has shorter hands

Functional aspects, such as motivation and emotions also act as performer constraints (Renshaw et al. 2010). The previous stair example can be used to highlight this as well. Again there are two people who encounter the stairs. The first one is happy and energetic and uses an activity meter to estimate the number of stairs they climb daily. The second one on the other hand has just finished a long shift at work and is extremely tired. The first one will probably run up the stairs without a thought while the second one might simply use the elevator.

It is crucial for practitioners to understand how performer constraints affect learning in order to better facilitate it (Chow et al. 2016, 53). An important aspect of that is the identification of rate limiters for individual learners (Renshaw et al. 2010). Rate limiters are factors that negatively affect the learning process of an individual (Brymer & Davids 2014; Chow et al 2016, 5). They can be physical performer constraints like strength or flexibility, task constraints such as an uke (the one who the techniques are applied to) who is significantly heavier or even environmental such as the surface friction of the tatami. Identifying the rate limiters allows the practitioners to

modify the relevant constraints and thus facilitating learning for the individuals (Chow et al. 2016, 5; Correia et al. 2017).

2.2.2 Environmental constraints

Environmental constraints are described as physical and sociocultural factors (Chow et al. 2016, 54) that affect human movement (Chow et al. 2009; Newell 1986). Physical environmental constraints include factors such as ambient light, temperature, floor surface (Chow et al. 2016, 54). An important factor in judo is also the tatami structure. There's a significant difference between practicing throws on a tatami laid out on a properly built sprung floor and a tatami that is simply laid on concrete. Gravity is also a good example of an environmental constraint (Davids et al. 2008, 40; Renshaw et al. 2010), although it remains close to identical everywhere.

Sociocultural environmental constraints, on the other hand, include family support and societal expectations (Chow et al. 2009; Renshaw et al. 2010). Some environmental constraints, such as the floor material and ambient light can be modified by the practitioners to provide variation to the learning process. But most of them will remain relatively stable and require acknowledging and understanding more than modification.

2.2.3 Task constraints

Task constraints are often considered to be the most important category of constraints for practitioners due to their significance in learning (Chow et al. 2016, 54; Renshaw et al. 2010). They include such factors as the rules of the game, the boundaries of the playing area, the equipment used and the sources of information present (Chow et al. 2009; Davids et al. 2008; Renshaw et al. 2010). Contrary to environmental, and especially performer constraints, task constraints are relatively easily controlled by the practitioner.

The clever modification of task constraints allows the practitioner to direct the learners' search of the perceptual-motor landscape towards specific movement solutions (Chow et al. 2016, 54; Orth, van der Kamp & Button 2019). For example, adding multiple goals in territorial games such as ice hockey or floorball can be used to reduce the common problem of too many players crowding the ball (Chow et al. 2016, 54). An example in judo context might be the challenge

of crossing one's feet that especially beginners face. A rule could be introduced where a player can, during randori (a free form of training replicating a competition where both players do their best to win), call "crossed" whenever they notice the opponent crossing their feet. The crosser has to freeze while the caller gets five seconds of time to perform a throw. After either five seconds, or a successful throw, the randori continues.

Equipment modification is also an important tool for practitioners (Chow et al. 2016, 55; Renshaw et al. 2010). Through the use of modified equipment, practitioners can provide the learners with variation but also make the games easier (Chow et al. 2016, 55) or more difficult, depending on the learners' needs. Especially with children, using modified equipment is important to ensure that the important parameters of the sport in question remain proportional to their size compared to adults (Buszard, Reid, Masters & Farrow 2016; Chase, Ewing, Lirgg & George 1994). In sports like tennis or floorball, where the use of equipment is an integral part of the sport itself, it is easy to acknowledge the benefits of equipment modification. In judo, it may be more difficult to recognize its possibilities.

Equipment is usually something that athletes throw, kick or otherwise manipulate. At first glance judo might seem to lack equipment, but upon closer inspection, there is one significant factor that might be relevant to equipment manipulation: the one who the techniques are applied against (uke). Similar principles concern the manipulation of uke as they do other equipment. By modifying uke's actions and posture, the techniques or games can be made easier or more difficult depending on the learner's needs. This will be discussed further in Chapter 6.

By manipulating the equipment or other task constraints, practitioners provide learners with opportunities to practice individualized movement solutions that take into account their own performer constraints and their interaction with environmental and task constraints (Chow et al. 2016, 55; Farrow, Buszard, Reid & Masters 2016). As opposed to prescribing a desired movement pattern and having learners replicate that. By focusing on movement outcome instead of movement pattern and manipulating task constraints to facilitate its emergence, practitioners can better facilitate the emergence of individualized movement solutions. After all, since performer constraints, and to some extent also environmental constraints, are unique for each individual learner, variation in movement solutions between individuals should be expected (Chow et al. 2016, 55; Davids et al. 2008). Chow et al. (2016, 55) describe this phenomenon by stating that while the general shape of a movement can, and should, be identified, individual variation should be regarded as the norm rather than the exception.

2.3 Information and action - perception-action coupling

As mentioned earlier in this chapter, CLA is underpinned by two scientific frameworks, dynamical systems theory and ecological psychology. Together they are considered to form one coherent framework called ecological dynamics. Dynamical systems theory and its contribution to CLA and ecological dynamics was discussed earlier, this subchapter aims to explain the implications of ecological psychology (Gibson 1979).

Ecological psychology concerns how neurobiological systems, in this study's context humans, coordinate their actions with their environment (Davids et al. 2008, 56). An important concept is the surrounding energy arrays, such as optical, acoustic and proprioceptive, acting as sources of information to guide those systems' behavior (Chow et al. 2016, 30). Meaning that our senses (e.g. sight, hearing and sense of touch) provide us with information that guides our actions (Profeta & Turvey 2018).

While this may seem obvious, it carries significant implications for skill acquisition. Especially when coupled with Gibson's (1979) notion that perception isn't a static process, but rather a dynamic one. Gibson (1979, 223) highlighted the circular relationship of perception and action (Davids et al. 2008, 56) with his famous words "So we must perceive in order to move, but we must also move in order to perceive". That circular relationship can be explained with an example from football: a player who is standing still, undecided on what to do next. can gain information on the situation by looking around, i.e. perceiving, and use that information to decide his next move. When he then moves, his perception changes because he isn't in the same place anymore. That movement causes him to perceive aspects of the field that he wasn't able to see before.

Perception is easily regarded as what we see, but while sight is an important tool for healthy humans, when learning to coordinate our actions with the environment, it is not the only one. We also use, among others, hearing, proprioception, i.e. the sense of body position and movement (Tuthill & Azim 2018), and our sense of touch to perceive ourselves in regards to our surroundings. Especially in judo, and other combat sports, proprioception and the sense of touch are extremely important tools for perception (Jaakkola 2010, 68). Consider an example from ne waza (fighting on the ground in judo) where one player is pinning the other one on their back. The bottom player will often try to create space between them by moving their arms under the top player and pushing them away. An advanced judoka will easily recognize the

attempt when they feel the other player's arms move underneath themselves. As Gibson (1979) stated, that perception allows the top player to move accordingly. Newell (1986) included this perception-action coupling into his framework on the emergence of movement coordination and his view represents the fundamental idea behind ecological dynamics extremely well (see Figure 2)

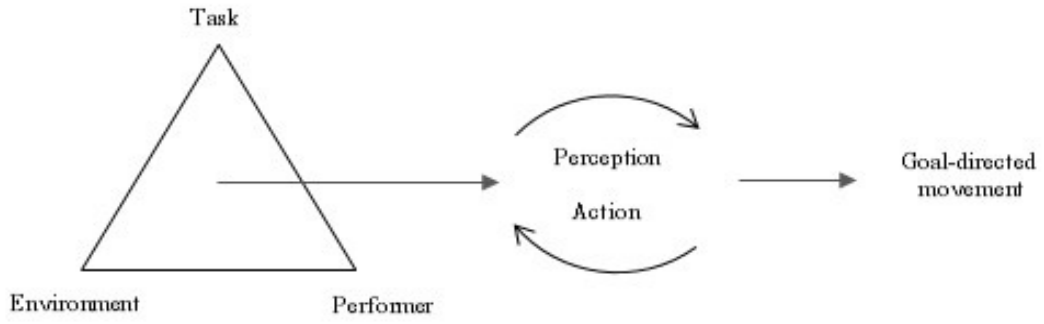

Figure 2. A constraints-led approach to skill acquisition. Adapted from Newell (1986).

Affordances. It is relatively easy to understand that seeing our surroundings allows us to act in a suitable manner. The question that ecological psychology aims to answer, however, is what we actually perceive. Bernstein (1967) and Gibson (1979) proposed that neurobiological systems, i.e. humans in this instance, perceive information based on what opportunities for action it offers or demands. He meant that humans don't perceive objects by their qualities but rather based on what actions they afford us (Profeta & Turvey 2018). Those opportunities for action are called affordances (Gibson 1979). Since individual learners always have a unique set of constraints affecting them, the affordances are also different for each individual. Chow et al. (2016, 30), therefore propose that affordances should be regarded as functional relationships between the performer and the performance environment, rather than as static entities.

That individual nature of affordances can be explained by an example of encountering a tree that's fallen across the path. Depending on the height it rests on and the physical fitness (among other factors) of the individual, the situation might afford jumping or climbing over it. However, the next person encountering it might be shorter and less capable of jumping or climbing. For them the same situation probably affords walking around it. Although, Gibson (1979) also stated that affordances have both an objective and a subjective nature. In the tree example, his

idea could be highlighted by saying that the fallen tree does remain the same with both encounters. Therefore, theoretically, the same affordances are there, whether the individuals have the capabilities to act upon them or not (Profeta & Turvey 2018).

The same is true in a sports context. For example, when engaging in a judo match, players will perceive affordances and act on some of them. There are, however, also affordances that they miss. If the match was videotaped and analyzed afterwards, it is often easy to point out situations where a player had opportunities for attacks or where they could have defended more effectively, i.e. affordances. Some of them might be such that even knowing them, the players lack the capability to act on them, while others are simply situations where they didn't perceive the information revealing the affordance.

3 IMPLICATIONS OF ECOLOGICAL DYNAMICS ON SKILL ACQUISITION

Ecological psychology and dynamical systems theory together provide an ecological dynamics framework (Araújo, Davids & Hristovski 2006; Profeta & Turvey 2018) that provides insight into understanding human performance and skill acquisition in sports (Araújo et al. 2015; Davids et al. 2013; Lopes, Araújo & Davids 2014;Silva et al. 2013). This chapter aims to introduce the implications that the theory of ecological dynamics and CLA has on skill acquisition. Because, as Chow et al. (2016, 25) state, a pedagogical approach should always be based on a theoretical framework to explain how learning actually occurs. Before introducing the ecological dynamics perspective on learning, however, the traditional model of learning is discussed to create a point of comparison.

3.1 Traditional model of learning

A traditional, reproductive, model of learning emphasizes the repetitive attempts of learners to emulate a coach- or teacher-prescribed movement pattern that is considered to be optimal (Chow et al. 2016, 26). That optimal movement pattern is seen as something all learners should aspire towards and every deviation from it is seen as an error. Visual demonstrations and verbal feedback are used to guide learners in how the movement pattern should be performed (Chow et al. 2016, 26; Körner & Staller 2017), as opposed to focusing on the movement outcome and guiding learners towards it by manipulating constraints.

A major emphasis in traditional models is given to the amount of time spent training specific skills (Chow et al. 2016, 26). Erickson, Krampe & Tesch-Romer (1993) defined that time spent training as deliberate practice. According to Chow et al. (2016, 26) the focus in traditional theories is in automatizing movement patterns by constant repetition. That automatization is considered to be useful because it is said to release cognitive capacity for decision-making and planning in competitive situations.

There has been considerable criticism, however, for the traditional model of deliberate practice. One of the foremost aspects of it being criticized is its inability to produce intelligent and autonomous sport performers, rather than athletes that rely on the reproduction of the same movement pattern. Such relying on reproduction does not optimally facilitate learning in the sense Liu & Newell (2014) see it. They define it in accordance with ecological dynamics as

finding one's own functional movement solution to a task problem. Therefore, a learner should, through learning, be able to interpret situations in play and decide on and apply functional solutions that can be adapted based on the prevailing circumstances (Renshaw, Davids & Savelsbergh 2010).

Another reason for criticism is the focus on the time spent practicing, often at the cost of the question of what type of training would be optimal. As Chow et al. (2016, 28) point out, the consideration of practice task manipulation to facilitate optimal learning is often omitted. The overvaluing of time spent practising is also questioned due to the high amount of variation in practice time (Chow et al. 2016, 28) that's been reported for learners to reach expert level (Gobet & Campitelli 2007; Tucker & Collins 2012).

3.2 Ecological dynamics perspective on learning

Ecological dynamics provides insight into motor learning and human performance (Araújo et al. 2006; Profeta & Turvey 2018) and grants practitioners a model of learning that contributes to the fundamental principles of nonlinear pedagogy, which is introduced in chapter three.

A key assumption in nonlinear pedagogy is that the constraints in a practice task should reflect the constraints in the respective performance environment (Chow et al. 2016). This subchapter introduces the ecological dynamics' model of learning through its three key properties according to Chow et al. (2016, 29). The first one is the concept of affordances inviting actions. The second property of ecological dynamics is the emergence of movement coordination through motor systems' self-organization into functional movement patterns. The third key property is the functional movement variability and its role in athletes' adaptation to the inherent variation in performance environments.

3.2.1 Affordances inviting action

The concept of affordances was introduced in chapter one and here the aim is to discuss their relevance to designing practice tasks. Withagen, de Poel, Araújo and Pepping (2012) used examples from the field of industrial architecture to highlight the role of practitioners as learning designers. They made the point that by clever design, affordances are used to improve the functionality of our environment. Chow et al. (2016, 31) complemented their idea with

examples like the width of doorways to afford entrance and the handles used to push and pull doors. Their argument was that the designing of affordances can be used to guide human behavior.

That argument easily transfers to sport context as well: practitioners can use affordances to guide the learners towards functional movement solutions (Davids et al. 2013). In accordance with Davids et al. (2013), Chow et al. (2016, 31) further state that it is important for learners during practice to explore their performance environment and find affordances for specific actions. The multiple affordances that are present in a performance environment form the perceptual-motor landscape that was discussed earlier in chapter one. Chow et al. (2016, 32) propose that the exploration of that landscape leads to athletes discovering suitable affordances and learning to use them. Which according to Davids et al. (2013) is a part of acquiring expertise in sport.

Pohja's (2019) proposal on the three throwing opportunities in judo provides an apt example for the designing of affordances. The classification will be discussed in more detail in chapter 4, its principle is sufficient at this point. His main point is that there are three throwing opportunities in judo and each one of them affords certain types of throws. Therefore, coaches could use those opportunities to afford the execution of specific throws. For example, Pohja (2019) proposes that ouchi gari is afforded in a situation where the opponent's supporting leg is vulnerable in front of them. Thus, when practicing ouchi gari, a coach could design tasks that would facilitate the emergence of such situations, thereby creating affordances for the throw.

While it may seem relatively straightforward to design affordances for action into practice tasks, Chow et al. (2016, 32) emphasize the importance of also respecting the principle of representative learning design (Pinder, Davids, Renshaw & Araújo 2011) when doing it. Representative learning design is a pedagogical principle of nonlinear pedagogy that will be discussed further in chapter 3. Essentially it means that the task constraints in a practice task should reflect the task constraints of the actual performance environment (Araújo et al. 2006).

In a judo context, Chow et al. 's (2016, 32) point of retaining the representativeness could be highlighted by expanding upon the previous example of teaching ouchi gari. Simply having uke stand in the prescribed position, the supporting leg vulnerable in front of them, could be argued to represent the actual performance environment of randori or a match in competition better than them standing in a neutral position with both feet under their weight of mass. While it might be true, the prescribed static position is still quite far from the actual performance

environment. It could be an adequate place to start with complete beginners but quite soon it would be advisable to move to task designs that more closely reflect the competition setting. Such designs should include movement and some manipulation of uke to create the desired situation, instead of prescribing it.

3.2.2 Movement coordination through self-organization

The self-organization of the human movement system was introduced in chapter one and this subchapter further discusses the concept and its implications on skill acquisition. As mentioned before, complex systems are defined as systems composed of multiple interacting components that have the ability to achieve stable states of organization to produce functional behavior (Clarke & Crossland 1985). Examples of complex systems include weather patterns, insect colonies and stock markets (Chow et al. 2016, 33).

Humans as well as groups of humans are also considered complex systems, their parts, either body parts or single humans in a group, constantly interact with and affect each other. In a sports context, the same principle applies to athletes and sports teams. Athletes achieve performance goals like running and jumping, or in the case of judokas, throwing or pinning their opponent, by adapting their complex movement systems (Chow et al. 2016, 33) in a task-appropriate manner. Where an athlete achieves performance through intrapersonal movement coordination, sports teams accomplish the same goal through interpersonal coordination, i.e. by coordinating the interaction of multiple players with each other (Travassos et al. 2012).

According to research, complex adaptive systems achieve functional behavior, both intra- and interpersonal, through the formation of temporary patterns of coordination between their system component (Riley, Shockley & Van Orden 2011). The coordination patterns are formed in order to achieve a task goal (Chow et al. 2016, 33), after which the system re-organizes and continues to the next goal. The process of organization is similar both between an athlete's limbs and body parts as it is between members of a sports team. Chow et al. (2016, 33) describe the process as emerging from the informational constraints of the performance environment.

Their point can be further explained with examples from sports context. Consider a judoka being attacked in a match. They perceive the situation (i.a. the opponent's grips, movement and application of force) and realize they're being attacked. The constraints in the situation, coupled with their perception and decision to defend or counter-attack, lead to the self-organization of

their body to achieve the immediate task goal of forming a defensive posture or mounting a counter-attack. In the same way a floorball team's players might perceive an imminent attack and, based on their informational constraints, "automatically" form into a defensive formation. Both processes follow the same formula that Riley et al. (2011) and Chow et al. (2016) propose: informational constraints and task goals are taken into account and the systems then self-organize to form functional solutions.

The concept of functional movement coordination emerging through the self-organization of system components (based on the prevailing constraints), leads to the question of how to facilitate that process, i.e. how to make athletes learn skills more efficiently. As mentioned earlier, ecological dynamics and CLA encourage practitioners to consider learning as a process of exploring the perceptual-motor landscape, i.e. the available affordances, by trying solutions to a task problem (Newell 1986). Chapter three will introduce nonlinear pedagogy as a tool for practitioners to achieve that.

3.2.3 Functional movement variability

Variability in movement patterns has traditionally been seen as error (Davids, Glazier, Araújo & Barlett 2003; Preatoni et al. 2010), and the goal of learning a skill has been to replicate an optimal movement pattern as closely as possible (Chow et al. 2016, 26). However, current research suggests that the traditional view on movement variability is flawed. Barlett, Wheat and Robins (2007) along with Preatoni, Squadrone and Rodano (2005) argue that variability is an inherent part of movement coordination between individuals and also within individuals as well. Preatoni et al. (2010) suggest that the variability is a result of the extreme complexity of the human movement system that is always affected by a vast number of factors, including the ever-present constraints on action.

In practice, the concept of inherent movement variability means that universally optimal movement patterns don't exist, rather a movement solution can only be considered optimal for a specific individual under specific constraints. As Chow et al. (2016, 35) point out, it has been shown that long jumpers, for example, cannot place their feet in the exact same positions from trial to trial in their run towards the take-off board (Lee, Lishman & Thomson 1982; Scott, Li & Davids 1997). Given that it seems impossible for an athlete to exactly replicate their own previous performance, trying to replicate someone else's movement pattern seems relatively futile.

Theoretical knowledge and empirical data have both shown that movement outcome consistency does not require movement pattern consistency (Davids et al. 2003), i.e. experts achieve consistent performance (movement outcome) in various distinct ways (Seifert, Button & Davids 2013). In judo that concept can be exemplified by a judoka performing their favorite throw in competition. The desired movement outcome is a successful throw resulting in ippon (a winning score in judo). To win a tournament, the judoka needs to win several matches against different opponents, which means that they need to perform the throw against opponents with completely different fighting styles, limb lengths etc. It follows that to reach the desired movement outcome against various opponents, the player needs to be able to adapt their technique, i.e. the movement pattern needs to involve variation to reach the desired movement outcome.

That necessary variation in the movement pattern, to reach a desired movement outcome, is functional movement variability (Bootsma & van Wieringen 1990), which seems to be a key component in expert performance. It has been suggested that there are always multiple ways of solving a task problem in dynamic and unpredictable performance environments (Araújo & Davids 2011; Davids et al. 2003) and individuals are able to find different solutions, even under similar constraints, through a variety of functional movement patterns (Chow et al. 2016, 39). The next chapter will introduce nonlinear as a pedagogical tool for practitioners to facilitate that discovery of functional movement patterns for individual performers.

4 NONLINEAR PEDAGOGY AS A TOOL FOR TEACHING SKILL

There are numerous approaches to teaching skills in sport and physical education. Chow et al. (2016, 27) point out that past experiences have a considerable impact on learners' views on how to practice. They further argue that it is common for practitioners to base their teaching methods on past experiences that worked for them (Chow et al. 2016, 45). They do admit that such approaches can work but encourage practitioners to gain an understanding of how and why the method works or not.

To facilitate such understanding, it is important to form pedagogical approaches that are underpinned by current scientific theory and empirical data. Greenwood, Davids and Renshaw (2012; 2014) also point out that it is equally important to utilize the knowledge of expert coaches when developing pedagogical tools. Chow et al. (2016, 27) seem to agree with the notion as they described it as an important challenge to form pedagogical approaches that harness the experiential knowledge of expert coaches and combine that with the knowledge from ongoing scientific research. They state that such a method is crucial to ensure that opinions without proof, or the previously mentioned past experiences, do not bias learning designs in sport.

NLP is a pedagogical approach that meets those criteria. It is essentially a pedagogical tool that applies the previously introduced concepts of ecological dynamics into coaching practice.

4.1 Nonlinearity in learning

Motor learning, or motor skill acquisition, is traditionally defined as the internal processes that cause relatively permanent changes in the learner's movement capabilities (Schmidt & Lee 2011). Similarly, in ecological dynamics, it's defined as a process of change within the learner's intrinsic dynamics, i.e. the inherent characteristics of a learner's movement repertoire (Chow et al. 2016, 46). Since learning alters the intrinsic dynamics of a learner, it follows that instead of simply improving the performance of the movement pattern to be learned, it alters the entire layout of the learner's coordination dynamics (Schöner, Zanone & Kelso 1992). Meaning that when a new skill is learned, it may also impact related, already existing, skills the individual possesses (Chow et al. 2016, 46).

The process of acquiring movement coordination is most often nonlinear (Chow et al. 2011; Lee et al. 2014), and may involve plateaus, progressions and even temporary regression (Liu, Mayer-Kress & Newell 2006). The concept of nonlinearity provides a framework to better understand movement systems, since they are nonlinear in nature. To understand its implications, it is important to understand the difference between linear and nonlinear systems.

Features of a nonlinear system. Nonlinear systems share four key characteristics that distinguish them from linear systems. Those four characteristics are cause-effect non-proportionality (Button et al. 2020, 241), multi-stability (Pisarchik & Feudel 2014), parametric control and the functional role of noise (Chow et al. 2011; Chow et al. 2016, 50; Schöllhorn et al. 2006). Table 1 presents a comparison of linear and nonlinear systems.

TABLE 1. Key characteristics of nonlinear and linear systems (adapted from Chow et al. 2016, 51)

	Nonlinear systems	Linear systems
1	Non-proportionality	Proportional changes expected
2	Mono- and multi-stability	Mono-stability: one cause only produces one behavioral effect
3	Parametric control: modifications of parameters can alter the entire system state	Non-parametric control
4	Functional role of noise	Noise seen as undesirable

The first distinguishing characteristic is the cause-effect proportionality. In linear systems a small change in system behavior follows a small change in its cause, whereas in nonlinear systems, even a minor alteration in system dynamics may lead to major changes in system behavior or performance (Button et al. 2020, 241; Chow et al. 2011; Chow et al. 2016, 48). In other words, in nonlinear systems, a minor difference in constraints, may lead to completely different movement solutions. In practice task design, this implies that with small manipulations of task constraints, practitioners can guide the learners towards various movement solutions.

In judo this can be exemplified by a judoka who likes to perform a yoko tomoe nage (a specific throw) from a low sleeve-high lapel -grip (a specific type of gripping the opponent's jacket). They are extremely proficient in performing the throw, but their coach has noticed that when they don't manage to get their preferred low sleeve grip, they often get into trouble. To promote adaptability and variability the coach could introduce a rule where the end of the opponent's sleeve on one side is prohibited. It would lead to the judoka having to alter their attack completely. The minor modification in task constraints (a small part of the opponent's jacket is off limits) leads to a significant change in performance (judoka using a completely different throw).

The second characteristic of nonlinear systems is multi-stability (Pisarchik & Feudel 2014), meaning that one cause can have multiple behavioral effects (Chow et al. 2011; Chow et al. 2016, 49). The previous judo example works to explain this aspect of nonlinear systems as well. The small modification of task constraints (the forbidden grip) does not guide the learner towards a single specific movement solution, but rather affords them a wide range of options.

Chow et al. (2016, 49) also provide a good example from badminton, where the opponent hits the shuttlecock high. It affords the player with multiple possibilities of returning the ball, i.a. a drop shot or an overhead clear. They further point out that for a skilled individual, multi-stability provides an array or possible movement solutions, which Bruineberg and Rietveld (2014) call a field of affordances. They maintain that a comprehensive field of affordances improves an athlete's capacity for performance. Chow et al. (2011) explain the possible benefits with the variability the athlete faces, that facilitates the emergence of various states of coordination. Those various solutions help athletes to adapt to a wide range of constraints, thus improving their performance over a wide array of performance environments.

In the introductions of both previous key characteristics, practitioners' ability to modify task constraints, i.e. system parameters, was mentioned. That capacity to alter system parameters is another key aspect of nonlinear systems (Chow et al. 2011) and it emphasizes the importance of parametric control in guiding system behavior (Chow et al. 2016, 49). Parametric control implies that practitioners are able to modify system parameters (task constraints) to guide learners in their search for functional movement patterns (Chow et al. 2016, 49). Through guiding them, practitioners are able to expose learners to variable constraints during specific learning contexts thus facilitating their learning to adapt their performance (Chow et al. 2011).

Adapting to dynamic performance environments leads to the fourth distinguishing characteristic of nonlinear systems, the functional role of noise. Chow et al. (2011; 2016, 50) and Schöllhorn et al. (2006) state that traditional motor learning theories tend to deem variability as undesirable and therefore consider it as noise. In sports this has led to variable movement form between trials being considered an indicator of performance inconsistency (Chow et al. 2016, 50). However, as mentioned before, since there is no universally optimal movement pattern, variability across trials should not be considered undesirable but rather a possibility (Schöllhorn et al. 2006).

Chow et al. (2009) point out the important role that variability, i.e. noise plays in increasing the probability of the movement system (learner) transitioning between multiple states of coordination, i.e. trying out different movement solutions. As mentioned previously, being exposed to variable situations and exploring variable movement solutions help athletes adapt to changing circumstances.

The four characteristics discussed here (cause-effect non-proportionality, multi-stability, parametric control and the functional role of noise) distinguish nonlinear systems from linear ones. They also provide insight into the process of learning in nonlinear movement systems (Chow et al. 2011; Chow et al. 2016, 50). Chow et al. (2011) accredit their importance to the fact that they underpin the process by which learners adapt to changing performance environments. As mentioned earlier in this subchapter, these features of nonlinear systems also underpin the pedagogical principles of NLP, which are introduced in the next chapter.

4.2. Pedagogical principles of NLP

The foundation on ecological dynamics brings with it the consideration of human movement as complex, adaptive systems that are guided by information (Chow et al. 2016, 25). A constraints-led approach to skill acquisition (CLA) in turn contributes to NLP with its concept of constraints as the boundaries for the emergence of movement coordination. It also provides the notion of a cyclical perception-action coupling (Newell 1986). Finally, the characteristics of nonlinear systems provide an explanation for why human movement should be considered as a nonlinear adaptive system (Chow et al. 2016, 50).

4.1.1 Representative learning design

In sports, representative design refers to the generalization of constraints in a practice situation to those in the actual performance environment (Araújo et al. 2006). Meaning that a practice task resembles the actual task to be performed. In competitive judo, the actual performance environment is a competition match and practice tasks are what the athletes engage in when training.

In sports, especially in a highly dynamic sport like judo, athletes are faced with an ever-changing situation (Fajen, Riley & Turvey 2008) that they need to adapt to in order to perform successfully. The ability to analyze a situation and recognize affordances that might exist for only a fraction of a second is not inherent in humans, it must be learned. To learn it, athletes must be exposed to realistic learning environments (Fajen et al. 2008) to allow them to attune to the information available, which in turn helps them to make informed decisions (Chow et al. 2016, 58).

The concept can be demonstrated with a typical situation in judo: a beginner who already knows five or more throws but is not able to perform them in randori or competition, even against opponents of equal skill level. While there are admittedly numerous reasons for this, it is probable that the training in these situations has not been closely representative of randori. By training throws from static conditions, learners get better at that, but when faced with highly dynamic conditions, it is likely that their performance is significantly weaker. This is due to a concept called transfer of training (Issurin 2013).

Transfer of training is essentially the impact that previous training has on the actual performance and further training (Issurin 2013; Magill 2003). It can be exemplified in a judo context by a judoka who has already learnt the throw o goshi and is now practising koshi guruma (a throw with similar mechanics to o goshi). Their previous training will most likely impact their practice of the next throw positively. The effect has traditionally been explained by task similarity (Barnett & Ceci 2002). However, Chow et al. (2016, 90) point out that traditional view's problems in implying a specific, required movement pattern and the difficulty of quantifying tasks by their similarity.

NLP, on the other hand, provides a theoretical rationale for the process of transfer by analysing the phenomenon from the perspective of the interactive performer-environment relationship (Davids et al. 2017). In NLP, transfer is considered as the relationship between the intrinsic dynamics (the capability for action based on the prevailing constraints such as previous

experience, genes and skill level) of an athlete and the task dynamics (the properties of the task to be performed) (Zanone & Kelso 1992).

Transfer can be positive, negative or neutral (Davids et al. 2008; Jaakkola 2010) depending on the previously mentioned relationship between athlete and task dynamics. When the intrinsic dynamics of the athlete complement the task dynamics (i.e. the athlete's capability for action is in-line with the task requirements) transfer is positive (Zanone & Kelso 1992). Likewise, if the dynamics of athlete and task compete (i.e. the athlete's intrinsic dynamics don't complement the task dynamics) transfer is more challenging, or even negative (Zanone & Kelso 1992).

Chow et al. (2016, 90) pose the question of what actually transfers, according to ecological dynamics. According to Pinder, Davids, Renshaw and Araújo (2011), it is the information-movement relationship between a properly designed practice task and a competitive performance environment. Their rationale implies that the information that's present in the actual performance environment, needs to be represented in the practice environment (Chow et al. 2016, 91). Hence the term, representative learning design.

Designing representative practice tasks is not always easy, however. It requires practitioners to define the key informational factors present in a competitive environment and then design tasks that incorporate those factors (Davids et al. 2017). Despite the difficulty, using representative tasks is beneficial because it ensures that athletes develop the capability to explore the perceptual-motor landscape for functional movement patterns (Chow et al. 2016, 94).

4.1.2 Relevant information-movement couplings

Developing relevant information-movement couplings is a fundamental concept in NLP. Gibson (1979) even argued that without information, movement can not be functional. The previous principle of representative learning design is even based on the concept that movements in practice tasks need to be coupled to perceptual variables that simulate the performance environment, i.e. relevant information-movement couplings. (Chow et al. 2016, 94).

As stated earlier, information (perception) and movement (action) are closely intertwined. Therefore the task for practitioners is not to simply couple information and movement, since they're inherently coupled already, rather it is to ensure that the couplings are relevant to the actual performance environment (Chow et al. 2016).

Athletes rely on perceptual information to guide their movement (Chow et al. 2016, 30), which in turn generates further information to support following movement. Such a cyclical relationship of information and movement (Chow et al. 2016, 59) provides the basis for functional movement (Gibson 1979).

A judoka who has practiced throwing only from static conditions, i.e. both players standing still at the start, is a good example to highlight Gibson's (1979) idea. They constantly perceive their environment, in this case mainly the uke, and adapt their movement based on the perception. They are used to a certain perceptual-motor landscape that they explore while practicing. Their perceptual-motor landscape might include such movement patterns as manipulating uke's posture and balance, moving their own body and applying force to uke. While all those movement patterns are relevant if the task is to throw a neutral uke, the needs of a competitive environment are different.

When faced with a competitive setting where the opponent is resisting and even trying to throw you as well, the judoka needs to be attuned to completely different information. The core mechanics of throws remain the same, but a judoka needs to gather much more information on uke's movement, balance, grips and intentions than when throwing a neutral or co-operative uke. To ensure that athletes perform successfully in competition or randori, practitioners need to provide them with practice tasks that expose them to relevant information in order to facilitate functional movement (Chow et al. 2016; Pinder et al. 2011). The next principle will discuss the question of how to design tasks that are representative of the actual performance environment (the first principle) and therefore include relevant information-movement couplings (the second principle).

4.1.3 Manipulation of constraints

Establishing functional affordances (realistic opportunities for action) is an important concept in NLP. It can be accomplished when learners practice under representative circumstances (Chow et al. 2016, 59). Davids et al. (2008) suggest that manipulation of task constraints is a key tool for practitioners to exaggerate the relationship between information and movement to guide learners toward those functional opportunities for action. As discussed in chapter one, there are three types of constraints (performer, environmental and task) that affect the emergence of movement coordination, but task constraints are what practitioners have the most control over (Chow et al. 2016, 59).

Manipulating task constraints can emphasize the exploration of novel movement possibilities (Chow et al. 2016, 59). Task instructions like instructions, rules and activity are often easily manipulated to perturb learners and facilitate the acquiring of new movement solutions (Chow & Atencio 2014; Tan et al. 2012). In a combat sport setting, the concept was demonstrated by Hristovski, Davids and Araújo (2006) in a study on the manipulation of target distance in boxing. They showed that different scaled-body distances afforded different boxing patterns, i.e. jabs, hooks and upper-cuts.

Chow et al. (2011) explain the effectiveness of manipulating constraints by its ability to force the movement systems of learners to a meta-stable state. Meta-stability refers to a dynamical system's state of "partial organization" that exists between the stable state of coordination (where all system components are coupled to create functional movement) and the state of complete independence (where the system components are uncoupled and independent) (Chow et al. 2011). The benefit of forcing a learner's movement system to a meta-stable state lies in its tendency to facilitate the emergence of variable movement solutions (Chow et al. 2011). By weakening the stability of a movement system, the emergence of new solutions is encouraged.

That is what Chow et al. (2011) propose that task constraint manipulation achieves. According to them, it increases the amount of variability in a practice task and leads learners to two distinct possibilities. It can either lead them to finding a functionally optimal (optimal in the context of the specific learner's performance of that specific task) movement solution for the type of task in question, e.g. performing a specific throw in judo. Or it can lead learners to discovering new solutions to a specific task goal, e.g. performing a successful throw in randori.

4.1.4 Ensuring functional variability

As mentioned in chapter two, there is a significant difference in variability of the movement pattern (the organizational pattern of system components) and variability of the movement outcome (a sign of inconsistency in performance) (Chow et al. 2016, 66). Movement pattern variability is considered an inherent part of human movement in NLP (Chow & Atencio 2014; Chow et al. 2011) whereas movement outcome variability, i.e. inconsistency, is considered undesirable (Seifert et al. 2013).

In NLP, functional movement variability is considered an integral aspect in skill acquisition (Chow & Atencio 2014; Chow et al. 2011) due to its capacity to guide learners toward

discovering individualized movement solutions to specific task goals (Davids et al. 2008). An example of this was demonstrated by Chow, Davids, Button and Rein (2008) in a study on kicking a soccer ball. In their study, new functional movement patterns were acquired after a period of high movement pattern variability.

To encourage the learners to explore their perceptual-motor landscape for functional solutions, Chow et al. (2016, 60) suggest practitioners should perturb the learning experience by introducing variability in it. Manipulating the task constraints, as mentioned in the previous subchapter, is a good tool for this: the alteration of instructions, equipment and rules is a powerful method of adding variability into practice tasks.

In judo, variation can be introduced to all types of practice tasks, including the task of performing a specific throw as well as randori. When practising a specific throw, variation can be added by i.a. varying the grips of both uke and tori, varying the movement of both uke and tori, introducing actions for tori to produce reactions from uke that tori needs to adapt to etc. In randori, variation can be added by e.g. limiting the allowed grips or times that players are allowed to grip the opponent without throwing. A significant source of variation in judo are the changing training partners, it is extremely important to change partners to expose players to different opponents. Specific methods of providing variability in judo training are discussed in chapter 6.

4.1.5 Attentional focus

The fifth pedagogical principle underpinning NLP relates to altering the learners' conscious control of movement. Attentional focus can be classified as external or internal (Wulf 2007, 37) and the distinction is important since it affects the level of explicit movement control (Chow et al. 2016, 60). An external focus of attention leads to a sub-conscious (implicit) control of movement, whereas an internal focus typically evokes a more conscious movement control (Chow et al. 2016, 60). According to Wulf (2007, 37) the focus of attention is external when the attention is directed to the outcomes of the action and, in contrast, it is internal when attention is directed to the action itself.

According to Bernstein's (1967) work, subconscious movement control leads to more effective movement solutions, since it allows learners to harness the self-organizing tendencies of the movement system. In contrast, Chow et al. (2016, 60) propose that conscious movement control

may lead to inferior movement solutions due to undesired breakdown of the movement. It is easy to understand since expert performance in most sports requires multi-articular coordination and consciously controlling multiple limbs simultaneously is extremely difficult, if not impossible.

However, Chow et al. (2016, 60) also point out that there are also implications that the impact of attentional focus may be task- or skill-dependent. They emphasize that the benefits of an external focus of attention are clearest in skilled performers, whereas beginners might benefit from some level of an internal focus (Beilock, Carr, MacMahon & Starkes 2002). Even in the case of novices, they suggest that after finding a rough approximation of the skill to be performed, it is advisable to shift the learners' attention outwards to avoid high levels of conscious control.

The attentional focus of learners is easily affected by practitioners. Peh, Chow and Davids (2011) emphasize the role of instructions in influencing the learners' focus of attention. They suggest that practitioners can guide the learners to focus their attention either to the effects of the movement (movement outcome) or the body movements (or body parts) involved in producing the actions.

4.3 Instructions as information

As argued in chapter one, human movement is inherently information-driven (Chow et al. 2016, 25) and therefore it is easy to understand why the role of information-movement couplings (discussed earlier in this chapter) is integral in NLP (Chow et al. 2016, 102). Learners constantly gather information from their surroundings and use that information to support their decision-making and actions. In NLP, the information provided by practitioners (i.a. instructions and feedback) should be considered as a specific type of constraint that interacts with performer, environment and task constraints (Newell 1986) to shape the learners' behavior. However, those temporary informational constraints (instructions and feedback) may act negatively or positively in shaping behavior (Chow et al. 2009), i.e. they can either improve or hinder performance, depending on how it is used (Chow et al. 2016, 120).

Chow et al. (2016, 103) suggest that a practitioner's role is to provide augmented (additional) information to guide the learner's search of functional movement solutions. They describe the provision of augmented information as providing a shortcut for the learner by guiding them to

search specific (instead of global) areas of the perceptual-motor landscape. Their idea can be explained with an example from judo, where a player is learning a new throw. There are numerous sources of information and a multitude of ways to solve the motor problem (performing a successful throw). A practitioner can facilitate the process by guiding the learners' search toward functional solutions, e.g. by suggesting where the learner should focus their attention.

When deciding what information to provide the learners, Newell and Ranganathan's (2010) distinction of movement pattern and movement (task) outcome is important to consider (Chow et al. 2016, 123). Since it is assumed that optimal movement patterns don't exist (Barlett et al. 2007; Preatoni et al. 2005; 2010) Chow et al. (2016, 123) suggest that information should be focused on movement outcome instead of movement pattern. Their notion is also in agreement with Bernstein's (1967) proposal that an external focus of attention (movement outcome) leads to more effective movement solutions.

Given that the practitioners' task is to direct the learners' search of functional movement solutions, the question becomes, how to do it. Chow et al. (2016, 123-129) list three different situations that practitioners face and provide suggestions on how to direct the learners' search in each situation. They also provide recommendations on how to use questioning as a tool for directing search and how to avoid negatively affecting the learning process.

Directing search when the key information source is known. It is relatively common that practitioners are aware of the key information source, in which case their task is to ensure the learners are able to focus their attention on it. According to Chow et al. (2016, 124), distracting information can often disrupt a learner's focus on the key source, resulting in them focusing their attention on something trivial.

In judo, a good example is the performance of certain foot sweeps that require precise timing (García García, Carratalá, Sterkowicz & Escobar-Molina 2009), such as harai tsurikomi ashi (Inman 2005, 46) and okuri ashi barai (Kashiwazaki & Nakanishi 1995, 72). Both Inman (2005, 46) and Kashiwazaki and Nakanishi (1995, 72) emphasize the importance of timing the sweeping action to the start of uke's action to move their foot (the one that tori is about to sweep). The movement of uke's foot, or the necessary shifting of their weight to perform it, could be considered a key information source in these throws. However as with all judo throws, there is a multitude of other information sources as well and especially beginners struggle with distinguishing the relevant information from all the irrelevant.

Practitioners can use various ways to ensure learners maintain focus on the key information source, and Chow et al. (2016, 124) suggest one convenient method that Gallwey (1974) designed for tennis. Gallwey (1974) came up with the method when trying to get learners to maintain focus on the key information source, i.e. the ball, for long periods of time. He called the method "bounce-hit" and it consisted of players simply yelling out "bounce" when the ball bounced on their side of the court and "hit" when they hit it. In addition to players maintaining focus on the ball for longer times, he also found that the temporal organisation, i.e. timing, of their shots improved.

Chow et al. (2016, 124) suggest that simple modifications to the "bounce-hit"-method might allow it to be used in different sports as well, e.g. using it for wicketkeepers in cricket as "bounce-catch". In the case of the previous judo example it could be called "shift-sweep" and players would need to call out "shift" when they perceive uke shifting their weight or moving their foot and "sweep" when they make contact with uke's foot with their own.

Such methods that help learners focus their attention on key information sources potentially help them to maintain focus in distracting conditions (Chow et al. 2016, 124). Chow et al. (2016, 124) also point out that the method provides learners with an external focus of attention which, as discussed before, may help athletes to harness the self-organizing tendencies of their movement systems (Bernstein 1967; Wulf 2007).

Directing search when the key information source is not known. The previous method works well when the practitioner knows the key information source, i.e. where to focus the attention. However, using instructional constraints to guide an athlete's search is problematic when the skills they're trying to learn are complex, e.g. judo throws. In whole body movements that require the interaction of multiple limbs, knowing where to focus attention is difficult (Chow et al. (2016, 126).

Chow et al. (2016, 126) highlight the problem with an example from badminton, where a player is attempting a net roll (a shot that is played close to the net by "rolling" the shuttlecock over the net as close to it as possible). The shot requires considerable control and through the coordination of multiple limbs, which makes it difficult. Attempts often result in popping the shuttlecock too high over the net, or having it fall on the player's own side of the net. Focusing on a single component might not improve performance at all. Instead, Chow et al. (2016, 126) propose two methods that rely on the athlete associating their movement pattern with the movement outcome in order to become more aware of the process.

They suggest that practitioners could start by asking the athletes to contrast the feeling of a successful trial and an unsuccessful one and build a scale from one to ten based on those feelings. In the previous badminton example, they propose that the practitioner should ask the athlete to perform a shot that pops the shuttlecock too high and assign the firmness of that shot a value of ten. Then the athlete should perform another shot that doesn't propel the shuttlecock over the net at all. That shot would be assigned a value of one. Then through practice, the athlete should try out shots that they associate with specific values. Through such a process, the athlete might find a suitable movement pattern to achieve the task goal (rolling the shuttlecock over the net as close to it as possible).

A simpler method Chow et al. (2016, 126) propose relies on having athletes describe their feelings when performing successful and unsuccessful trials. Then the practitioner, together with the athlete, could summarize the feelings associated with successful trials into analogies or keywords that the athlete can focus on when performing the movement.

The same methods can be applied to judo as well. For example, a judoka trying to improve their performance of the throw uchi mata might benefit from the method of associating feelings (what they perceive) with successful and unsuccessful trials. Instead of simply performing attempts without being aware of what varies between them, the method would provide them with a perception of how a successful trial feels like. Using that perception as a focus of attention with future attempts may lead to improved performance (Chow et al. 2016, 127)

Directing search with beginners. As mentioned previously in this chapter, it is possible that beginners benefit from a certain level of internal focus of attention (Beilock, Carr, MacMahon & Starkes 2002). Chow et al. (2016, 129) propose that it helps them to establish a rough estimation of the required movement pattern. Even then, analogies describing the movement pattern (e.g. move the racket "up a ramp" when performing an overhand drive in tennis (Chow et al. 2016, 129) are preferable to prescriptive instructions on body part functions (e.g. bend your elbows and move your arms slowly upwards) (Peh et al. 2011).

Once a learner has acquired an approximation of the movement pattern, Chow et al. (2016, 129) recommend that instructional constraints start encouraging an external focus. That way the learners are encouraged to turn their attention from movement pattern to the outcome of the movement, which is considered beneficial for learning (Wulf 2007, 108).

Directing search through questioning. Given that NLP encourages practitioners to adopt a facilitative, rather than prescriptive, role (Chow et al. 2016, 122; Davids et al. 2008, 99) it stands

to reason that questioning could be an appropriate method for directing the learners' search. Harvey, Cope and Jones (2016) as well as Chow et al. (2016, 130) suggest that questioning as a method for directing search could facilitate the development of autonomous athletes who understand their own capabilities.

They argue that questioning could be beneficial in many ways. Firstly, it might provide a good tool for directing learners' attention to their feelings and thoughts. For example, describing the feelings of balance in riding a unicycle, or the feelings of performing a complex judo throw like yoko tomoe nage, might be difficult for a practitioner. Instead they could use questions to encourage the athletes to become aware of and describe their feelings.

Another consideration that Chow et al. (2016, 131) raise regarding questioning as a tool for directing search is the learner's stage of learning. Different questions could work for beginners in the explorative search phase and an advanced learner trying to improve their technique. They suggest that beginners may benefit the most from question that encourage exploration, e.g. "Can you show me as many ways to solve the task problem as possible?", whereas more analytical questions could benefit advanced learners more, e.g. "can you tell me when uke's center of mass is on the highest point of the fulcrum" when performing a certain type of judo throw (discussed further in chapter four). Chow et al. (2016, 131) also propose that questioning might promote inner motivation (Deci & Ryan 2000) through facilitating perceptions of competence, autonomy and relatedness.

The concept of a facilitative role, rather than a prescriptive one, entails the idea of using instructional constraints purposefully. However, more information is not necessarily better. From an NLP perspective, a struggling learner does not need as much information as possible, rather they need to be allowed to discover functional movement solutions themselves (Chow et al. 2016, 130).

5 JUDO FROM AN NLP PERSPECTIVE

The previous chapters have focused on the theory of skill acquisition. This chapter in turn will utilize the theory to conceptualize the sport of competitive judo. The chapter will begin with a short introduction of judo in general, but will soon focus on competitive judo from the perspective of skill acquisition.

Judo was derived from jujutsu in Japan in 1882 by Jigoro Kano (Inman 2005; Marwood 1992; Myllylä & Pilviö 1995; Pedro 2001). Kano eliminated all jujutsu techniques that he deemed dangerous (Inman 2005; Marwood 1992), resulting in a system that allowed athletes to apply all techniques fully without injuring the training partner (Myllylä & Pilviö 1995). Judo proved to be efficient (Pedro 2001) and spread around the world relatively fast. In 1964, judo was first introduced in the Olympics and today the International Judo Federation (IJF) includes national federations from 195 countries (IJF 2007). The olympic sport of judo is a high-intensity combat sport (Franchini, Bertuzzi, Takito & Kiss 2009) where two contestants fight each other to determine the winner.

In addition to the olympic version of judo, there are also other ways of practicing and competing in judo, e.g. freestyle judo (International Freestyle Judo Association 2014) and kata (a predetermined sequence of techniques performed with a co-operating partner) competitions. The olympic sport version is understandably the most widely spread and most practiced, which is why it is the focus of this study.

5.1 Rules of judo

For the purpose of this study, the term judo is used to refer to the olympic sport of judo that is conducted in compliance with the current IJF rules (IJF 2019). The rules contain slight modifications for younger players, but for simplicity, only the rules for adults are discussed here. The official rules have changed often and rather drastically in recent years, thus, the introduction to the rules presented here, should be considered only a description of a temporary situation. The current rules should always be verified from the IJF website (IJF 2019).

A judo contest lasts for four minutes or until one player scores an ippon, i.e. a winning point, submits or is awarded the penalty of hansoku make (IJF 2019). The point system is relatively

simple, including only two types of points: waza-aris and ippons. Scoring an ippon earns the player an outright win, whereas scoring a waza-ari only earns the point, and the contest continues, thereby still allowing the other player the chance to win. If the same player scores a second wasa-ari, the two are considered equal to an ippon and that player wins.

Scores can be earned by throwing the opponent or by pinning them on their back. Pinning the opponent for 10 seconds earns a waza-ari and 20 seconds an ippon (winning the contest). In ne-waza (fighting on the ground), players are also allowed to use chokes and joint locks to the elbow joint to submit the opponent. Applying a choke or joint lock wins the match when the other player signals that they submit, either by tapping (twice or more) with a hand or a foot or by calling out "maitta" (give up). (IJF 2019).

Judo contests start with both players standing a few meters apart facing each other. After the call of "hajime" (start) the contest begins with players trying to score by throwing the opponent. Throwing the opponent on their back in a controlled manner with speed and force earns an ippon (IJF 2019), ending the match. Respectively, a waza-ari is given for throws that don't meet all the four criteria of an ippon (IJF 2019). After attempted throws and throws awarding a waza-ari, it is possible that the players end up on the ground (ne waza), where slightly different rules apply. There, players are not awarded points for throwing, rather they can score by pinning the opponent on their back or by applying an arm lock or a choke to submit them. The time spent in ne-waza is limited and if there are no scores and the situation becomes static, the judge will pause the contest and order the players up, starting the contest again from the same positions as the start. (IJF 2019

If the contest time (four minutes) runs out with the players having equal score (either no score or both have one wasa-ari), the contest continues in golden score (IJF 2019). The golden score period starts immediately after the actual time ends and continues until one player scores a point (either wasa-ari or ippon) or earns a penalty of hansoku make (IJF 2019).

There are two types of penalties, shidos (slight infringements) and hansoku makes (grave infringements) (IJF 2019). There are a number of different ways to earn a shido, but essentially the reason will be that the player has engaged in negative behavior, e.g. not trying to attack, stepping out of the contest area or using false attacks. A hansoku make can be earned either by accumulating three shidos or by committing a single grave infringement, e.g. performing movements that are dangerous to either player or disregarding the referee's instructions (IJF 2019).

Judo contests are different from sports like boxing or mixed martial arts in that single contests are not organised, instead it is fought in competitions, consisting of contests against several opponents (IJF 2019). There are various elimination bracket systems that determine which players face each other, however there are a few ground rules. Men and women have separate categories and in those, players are organized into specific weight categories (IJF (2019). Meaning that players of same sex and similar weight will face each other.

5.2 Tactical analysis of a judo contest

The Olympic sport of judo is not a self-defense system, rather it is a game concerned with winning by scoring points and imposed with rules to make playing it safe and fair (Kozub & Kozub 2004). As such, it has two different aspects to it, the technical and the tactical aspects. Brooker, Kirk, Braiuka and Bransgrove (2000) argue that traditionally, the technical side has been emphasized, with practitioners focused on developing the learners' fundamental sport skill (e.g. in the case judo, various throws, pins and submissions).

Their argument is supported by the views of NLP, and especially the pedagogical principle of representative practice tasks (Chow et al. 2016, 57). By trying to perfect techniques separately and out of context (in conditions that are vastly different from the actual performance environment), the contextuality of the skills is lost (Brooker et al. 2000), i.e. the information-movement couplings are not relevant (Newell 1986).

Referring to arguments such as Brooker et al. 's (2000) Kozub and Kozub (2004) propose that a tactical games approach may improve the teaching of judo. Weers (1997a) also emphasizes the importance of teaching tactics to judokas, even those new to the sport. Chow et al. (2016, 154) suggest that the same is true in games in general. They argue that one of the key elements in learning to play a new game, a player needs to learn the rules and the repeatable game structures.

Judo is a fast-paced game that is difficult to follow and understand for someone who isn't familiar with it. Despite its intensity, it still retains the basic components of most games, both players strive to score points and at the same time prevent the opponent from scoring (Kozub & Kozub 2004). To better understand the complexity of a judo contest, it should be divided into smaller components. Pohja (2019, x) proposes that the division should be into fighting ("perusottelu"), i.e. a contest over control of the match, and the execution of techniques, i.e. the

attempt to realize control into scoring points. He divides fighting further into neutral-, attacking- and defending phases, with attack and defense being player-specific (one is attacking which leads to the other one defending). This subchapter focuses on the fighting component (Pohja 2019,) and the execution of techniques will be discussed later.

As mentioned earlier, a judo contest takes place both in tachi-waza (standing up) and ne-waza (on the ground). However, the rules of judo place a greater emphasis on tachi waza (IJF 2019) and their skills in stand-up grappling is what judokas are generally best known for. Thus, this study will also emphasize the fighting in, and techniques of, tachi waza, although ne-waza will also be addressed.

Whether on the ground, or standing up, a judo contest is essentially a contest of control (Pohja 2019, x). Both players seek to control the opponent through controlling the space between them, which is where all attacks take place (Pohja 2019, x; Weers 1997b). The main tool for controlling the space, and therefore the opponent, is gripping (Pohja 2019, x; Takahashi 2005, 90; Weers 1997b). The aim with offensive gripping is to manipulate the opponent into a position that exposes them for attacks, affording the execution of techniques in order to score.

5.2.1 Gripping

Gripping is a fundamental part of competitive judo, due to its capacity to allow both the performance of offensive techniques (Adams 1992; Calmet, Miarka & Franchini 2010; Weers 1997a), and effective defensive maneuvers (Takahashi 2005, 90). Takahashi (2005, 90) even argued that gripping could be considered a form of art in itself, which captures the extremely important role that it has in contemporary judo. Grips are used both in tachi-waza (standing up) and ne-waza (on the ground) to manipulate the opponent, but due to the greater role of tachi waza in competitive judo, in this study gripping is considered mainly from the point of view of tachi waza.

When considering grips, it is important to understand the concepts of the lapel hand (tsurite) and the sleeve hand (hikite) (Pohja 2019, 29-30; Takahashi 2005). Lapel hand is the one that controls the space between the contestants, and applies power to lift the opponent (Takahashi 2005, 93), among other things. It is usually placed high on the opponent's lapel (Pedro 2019; Takahashi 2005, 93). The sleeve hand, in turn, is the one that usually grabs the opponent's sleeve in order to control it (keep it from gripping the player's own gi), and to apply pulling

force, as well as guide the opponents fall, when executing throws (Pohja 2019, 29; Takahashi 2005, 92).

Despite being common, the previously mentioned placements of the lapel hand and the sleeve hand are only one option. There is a huge variety of different ways to grip the opponent's gi (the jacket judokas wear) (Adams 1992, Takahashi 2005), and for simplicity, different grip situations are often divided into four categories: same-sided grips (ai-yotsu), opposite-sided grips (kenka-yotsu), symmetrical (or sleeve-end) grips and grips with no form (Pohja 2019, 30; Weers 1997a). Even though slight variations exist in where exactly the hands are placed on the opponent's gi, the key dynamics of these three situations remain stable.

Same-sided gripping means that both players fight with the same sided power hand, i.e. both use their right or their left hand as the power hand (Pohja 2019, 30; Weers 1997b). Opposite sided gripping in turn means that both players use the opposite sided hands as power hands, i.e. right vs. left or left vs. right (Pohja 2019, 30; Weers 1997b).

A player's stance also reflects the power hand side, meaning that a player who uses their right hand as their power hand will fight with their right foot forward (and vice versa) (Pedro 2019). Since players spend considerable time fighting for grips (Calmet et al. 2010), during which time they have no power hand to be distinguished, the term stance is used to describe the player's preferred power hand and their foot position.

While same-sided and opposite-sided grips are most common, symmetrical grips are also used. In a symmetrical grip, one player grips both of the opponent's sleeves or lapels (Pohja 2019, 31; Weers 1997b). The three first gripping situations (same-sided, opposite-sided and symmetrical) are similar to each other in the sense that in all of them, players are trying to set up their power hand (and often the sleeve hand as well) and keep it in place until they attack (Weers 1997b). Gripping without form is different.

Players who grip without form don't commit their power hand until they actually attack (Pohja 2019; Weers 1997b). Instead they use mobility to prevent the opponent from scoring and constantly search for opportunities to attack (Pohja 2019, 31; Weers 1997b). This strategy requires great physical fitness and skill to perform successfully. According to Weers (1997b) this strategy is used most often among elite players and in the final rounds of tournaments.

Analyzing gripping situations is important because a player's stance indicates to which side their throws are most effective (Courel, Franchini, Femia, Stankovic & Escobar-Molina 2014;

Pedro 2019). Right-sided judo players (players who fight with their right foot forward and use their right hand as the power hand) will usually perform right-sided throws (throws that use the right hand as the power hand) and left-sided players vice versa. While attacks on the opposite side are relatively common, Courel et al. (2014) reported that throws on the same side were statistically more successful.

Calmet et al. (2010) also studied gripping but their focus was on the time spent fighting for grips and actually gripping the opponent. They found that there was a distinct difference between experts and novices in that regard. Novices tend to spend almost the whole contest (86%) gripping the opponent, while experts only used 24% of the time with grips in place. They suggested that the emphasis with beginners is on trying to throw the opponent when the grips are in place, while experts concentrate on gripping the opponent without being gripped themselves.

Gripping strategy is an important aspect of judo (Pedro 2019; Weers 1997b) and there are different approaches to it. Pedro (2019) suggests that players should only use their preferred side and thus either fight using same-sided or opposite-sided grips depending on the opponent's stance. Courel et al. (2014) in turn propose that players might adopt an opposite-sided gripping situation to maintain distance from the opponent, thus making defending easier. Regardless of strategy or gripping situation, experts seem to agree on one thing regarding gripping: when you get a good grip, you must throw (Pedro 2019; Weers 1997b). After all, grips are (only) a tool used to allow scoring.

5.2.2 Opportunities for attack

Once a player has achieved a grip on the opponent in tachi-waza (standing up), they still need to execute a throw. Simply having grips on the opponent isn't enough, though. In order to throw, a player must create an opening (Kozub & Kozub 2004), i.e. they must maneuver the opponent into a vulnerable position. Executing an attack against an opponent with a balanced posture and the capacity to move, is not advisable, since it easily leads to the player getting countered, i.e. the opponent performs a counter throw (Pohja 2019; Weers 1997c). Pohja (2019, 35) even suggests that throws can be divided into two parts: the actual execution of the technique and the opportunity (affordance) for it. The execution will be discussed further later in this chapter, while the opportunities are discussed here.

To better understand when to attack, Pohja (2019, 36) and Weers (1997c) distinguish three positions of vulnerability that afford attacking with throws. The first position is when a player's supporting leg, i.e. the leg bearing most of the player's weight, is in front of their center of mass (or their body), in the space between the contestants. The second one, conversely is when the supporting leg is behind the player's center of mass. The last position of vulnerability according to them is when the opponent gets close (i.e. to a hugging distance) to the player's side or back and has a good posture that allows for lifting.

Both Pohja (2019, 36) and Weers emphasize the importance of knowing and recognizing these positions, both as an offensive tool to allow effective attacks but also as a tool to help players to defend by avoiding the positions themselves. The role of grips in attacking and defending has already been discussed, but there are also two other important factors to consider: posture and mobility (Pohja 2019, 29; Weers 1997c).

Posture forms the very foundation of a player's game. Weers (1997c) describes posture as a compromise between power and ease of movement or speed. The more a player is crouched (bending at the knees and hips to lower their center of mass and keep their back straight), the more force they can apply, but at the cost of mobility (Weers 1997c). Likewise, the straighter a player stands, the easier they can move, but again at the cost of potential force application (Weers 1997c).

Similarly to posture, mobility is an important aspect of the game in all its phases (neutral, attack and defense) (Pohja 2019, 33-34). In the neutral and attacking phases, players use movement to search for affordances by feinting attacks and gauging the opponent's reactions, as well as to move the opponent with the aim to unbalance them and recognize (or create) opportunities for throwing (Pohja 2019, 33-34).

Movement is also an important tool in defending. Understandably, since the opponent wants to manipulate them into a position of vulnerability, a player should always strive to avoid it. Mobility (along with gripping) is an important part of that. Pohja (2019, 34) defines a player's task in defense as one of maintaining good posture and mobility and anticipating the opponent's attacks. He proposes that performing those actions successfully increases a player's chances of countering the opponent's attacks and transitioning into an attacking role (Pohja 2019, 33-34).

5.2.3 Ne-waza: Fighting on the ground

The previous tactical aspects were mainly concerned with tachi-waza (standing up judo), although most of the principles do apply in ne-waza as well. Since a contest can be won on the ground as well (IJF 2019), judokas must be proficient in ne-waza too. Sometimes, depending on a judoka's strategy, they may even focus on bringing the fight to the ground and winning there (Takahashi 2005, 81).

Similarly to tachi-waza, where players usually fight in same-sided or opposite-sided positions (Pedro 2019; Weers 1997b), there are distinguishable recurring positions in ne-waza as well (Takahashi 2005, 81). When standing up, players have more mobility and therefore more possibilities to evade attacks (Pohja 2019, 34) than on the ground. Conversely, in ne-waza the increased amount of contact between players decreases movement opportunities and often leads to one player being forced to defend (Takahashi 2005, 81).

The recurring positions according to Takahashi (2005) are: turtle position, flat position, guard position and half-guard position. Both the turtle- and flat positions are used almost solely for defense. In them, the defending player is either on their knees and elbows (turtle position) or on their stomach (flat position) (Takahashi 2005, 82-83). They keep their elbows close to the body and protect the neck with their hands. All "openings", e.g. space between limbs and body are kept as tight as possible to prevent attacks. The aim in these positions is to prevent the opponent from mounting successful attacks and wait for the referee to call "mate" to start the contest again from the starting position (Takahashi 2005, 81).

The problem with those positions is that using them gives all the initiative to the opponent (Takahashi 2005, 81). If the opponent is a good ground fighter, the defending player may quickly end up in a losing situation. There are also other positions, that are not necessarily as defensible, but allow attacking more effectively than the turtle or flat positions. The two most commonly used ones in judo are the guard position and the half-guard position (Takahashi 2005, 84-86).

In the guard position, the player is on their back with the opponent between their legs (Takahashi 2005, 84). In half-guard, the player on the bottom only has one of the opponent's legs between their own. The difference between the guard positions and the turtle and flat positions is that the guards allow opportunities for attack for both players (Takahashi 2005, 84; Spencer 2016). Therefore, depending on a player's strategy, when the fight goes to the ground, they may strive to attain a strictly defensive position and wait out or they might try to get into a guard position and launch an attack from there. The previously mentioned four positions are

neutral in the sense that neither player is immediately scoring. In addition to them, there are of course the recurring positions of the actual techniques used to score (IJF 2019)

Since judo contests always start standing up, the key aspect of ne-waza is the transition there from tachi-waza. Both players strive for control during the transition (a throw) and the one who has it when on the ground is at an advantage (Pohja 2019, 37). Understandably the original attacker has a slight head-start since the other player must also avoid ending up on their back to prevent the other player from getting scores for their throw.

When on the ground, the same elements of e.g. posture, mobility and grip, still apply, but the pace of the contest is slower (Pohja 2019, 37). Kozub and Kozub (2004) define ne-waza through the same three tactical problems as tachi-waza (positive gripping, scoring and preventing the opponent from scoring). They point out that in neutral positions, players should use positive gripping (i.a. occupying the opponent's limbs and flattening them down) to attempt scoring. In order to score a player must gain a superior position and control the space between the contestants (Kozub & Kozub 2004; Pohja 2019, 33). Conversely, the defending player should maintain good posture and either create space between the contestants or stay balled-up tightly (Kozub & Kozub 2004) to prevent the opponent from gaining purchase on the player's limbs (Pohja 2019).

There is a tendency to favor tachi-waza and ne-waza is not always valued very highly (Pohja 2019, 37). Takahashi (2005, 81) also points out that the current rules also favor tachi-waza and the time allowed for the players to attack on the ground is rather limited. Thus, it is relatively common to see players adopting defensive positions on the ground simply to use up the remaining time when ahead in points (Takahashi 2005, 82).

5.3 The role of perception in judo

Pohja (2019, 18) describes judo as a sport demanding constant decision-making. He maintains that in order to succeed, a player must analyze their own, as well as the opponent's, posture and grips. And since the situation changes constantly, the player must update their analysis respectively. Somewhere in that ever-changing situation they must also find an opportunity to attack and successfully execute a technique suitable for that specific situation (Pohja 2019, 21).

However, in a more general skill acquisition sense, Chow et al. (2016, 37) point out that relying completely on reacting to perceptions may lead to the athlete being one step behind. On the

other hand, making a plan and following through with it regardless of the changing environment is not an advisable strategy either (Chow et al. 2016, 37). Instead Chow et al. (2016, 96) propose that performers need to be able to constantly switch between both strategies. Passos and Davids (2015) and Esteves et al. (2015) described the phenomenon in a football setting by suggesting that a player may have the global intention to dribble past a defender (a plan), but how the action takes place is an emergent process (body self-organizes based on the prevailing constraints).

That process is reliant on the athlete remaining aware of the environment and acquiring relevant information through perception. Distinguishing the relevant information is often difficult for beginners (Savelsbergh, Williams, van der Kamp & Ward 2002) thus they often focus their attention on irrelevant targets (Jaakkola 2010, 105). Experts, in turn, have often developed a skill to recognize the relevant information sources and focus their attention on them (Egeth & Yantis 1997).

Given that humans typically emphasize visual perception to support motor control (Davids et al. 2008, 56) it is logical that visual search strategies have been comprehensively studied across a range of sports. In judo, Piras, Pierantozzi and Squatritro (2014) reported that experts use fewer fixation points of longer duration, compared to beginners who shift their gaze often between focus points. Their findings support the notion that both foveal (the central, accurate, part of the field of vision) and peripheral vision is needed in controlling motor behavior (Jaakkola 2010, 61). According to Piras et al. (2014), expert judokas tend to anchor their gaze (foveal vision) to a central point (opponent's lapel or face) and supposedly use peripheral vision to anticipate movements of the opponent's limbs. In effect, experts used fewer fixation points of longer duration (shifted their gaze less) than novices. Similar results have been reported in other combat sports as well (Williams & Elliott 1999; Ripoll, Kerlirzin, Stein & Reine 1995).

While the important role of vision in fighting for grips in judo has been established (Piras et al. 2014), its importance after the grips are established is a controversial topic (Krabben, van der Kamp & Mann 2018; Krabben, Ravensbergen, Nakamoto & Mann 2019). The controversy originates from the lack of categorization of visually impaired (VI) judokas in the paralympics (Krabben et al. 2018, Krabben et al. 2019). Regardless of the level of their impairment, VI judokas are all grouped together and fight for the same medals, which has been proposed to favor the athletes with mild impairments, compared to completely blind athletes (Krabben et al. 2018).

To argue the point, Krabben et al. (2018) compared the performance of visually impaired and completely blind judokas and found that complete blindness resulted in less medals won compared to "only" having an impairment. Additionally, they studied the performance of sighted judokas with and without a blindfold and found that wearing a blindfold significantly impaired it. Their findings support the argument that vision affects performance in judo even after grips have been established.

Although the role of haptic and kinesthetic perception in judo hasn't been studied, it is safe to presume that they are crucial in providing necessary information to support decision-making and action. As Weers (1997c) and Pohja (2019, 36) propose, attacking opportunities are identified, i.a. by the opponent's posture and balance and, especially, their supporting leg. While vision may aid in the process, the role of haptic and kinesthetic perception is important in analyzing the opponent's posture and movement. Pohja (2019, 29) describes the process by suggesting that players should use their hands and arms to gauge the opponent's actions.

5.4 Technical analysis of judo from the perspective of NLP

The tactical analysis of judo provided insight into the type of game judo is. Its aim was to explain the rules and repeatable game structures that Chow et al. (2016, 154) suggest new players should always learn about their game. While it is definitely worthwhile to learn them, a judoka must also learn the specific tools that allow them to score, i.e. techniques. In judo, techniques can be divided into throws, pins, chokes and joint locks (Kodokan Judo Institute 2019; Pohja 2002).

Traditionally, practitioners across sports have tended to focus on movement pattern and body part placement, i.e. how to, specifically, organize one's body to perform the throw (Chow et al. 2016, 123). Instead, according to the theoretical basis of NLP, it is advisable to place an emphasis on movement outcome (Chow et al. 2016, 123).

In judo, as well as other combat sports (Körner & Staller 2017), techniques have often been taught by having the learners replicate a supposedly optimal movement pattern demonstrated by the coach. However, since the existence of an optimal movement pattern is widely questioned, a better method is needed. From an NLP perspective, Kelly and Weers' (1997) proposal that judokas should be taught the mechanics of techniques seems viable. Sacripanti (1987) further proposed that throws should be classified by their biomechanical features.

Though there are multiple ways to categorize dissect judo techniques a mechanical approach seems to be supported by NLP. Thus, in this study, the analysis of techniques is performed with a mechanical approach.

5.4.1 Throws

Traditionally, judo throws have been divided into five categories, i.e. hip throws, leg/foot throws, arm/shoulder/hand throws and additionally two types of sacrifice throws based on whether the tori lands on their back or on their side (Kodokan?; Sacripanti 1987). According to Sacripanti (1987) the reason for the categorization has been to facilitate the teaching and understanding of the techniques. Kodokan's traditional classification system is still most widely used, but there are also others (Dopico, Iglesias-Soler & Carballeira 2014; Sacripanti 1987). However, Dopico et al. (2014) point out that they are quite different from each other.

For example, Koizumi classified techniques based on uke's body movements (Dopico et al. 2014; Sacripanti 1987), while Gleeson (1967) and Sacripanti (1987) used biomechanical criterion to distinguish between types of throws. Dopico et al. (2014) also proposed a classification of their own that categorizes throws based on the motor control needed. Their justification for the type of classification is that it facilitates learning by grouping together throws with similar movement patterns.

One classification system is not necessarily better than any others, but for the purpose of this study, Sacripanti's (1987) classification method is used. From an NLP perspective, it stands to reason to teach learners how a technique works, not necessarily emphasizing how it should be done, in order to produce athletes who understand their own capabilities (Chow et al. 2016, 134). While Dopico et al.'s (2014) method is admittedly useful, e.g. when deciding which throws to teach together (due to their similar coordination patterns), when actually teaching a throw, a biomechanical explanation of how it works may be beneficial (Kelly & Weers 1997)

Sacripanti (1987) classifies throws into two categories based on the mechanical system tori uses to project uke on the ground. He calls the first category "throws of a couple of forces" and it consists of throws where tori uses a coupling of two opposing forces to rotate uke around their center of mass. Sacripanti (1987) further divides these throws based on the parts of tori's body that apply the forces, e.g. throws where the coupling of forces is applied with the arms and a leg or the torso and a leg etc.

The second category are throws where tori places a part of their body as a fulcrum against uke and then uses their body as a lever to rotate uke around that fulcrum. Sacripanti (1987) calls this category "lever throws". Similarly, to the first one, this category can also be divided further, in this case, based on the length of the lever. Therefore, the place where tori applies the fulcrum, e.g. near uke's ankle or just below their waist, and the place where they grip uke dictate how long the lever is, i.e. how much force is needed to rotate uke around the fulcrum.

From an NLP perspective, this method of classifying techniques is extremely useful. It provides the learners with an outline of how the skill should be done (2016, 55), while focusing on movement outcome, i.e. what needs to happen to uke, for the throw to be successful (they must be rotated either around their center of mass or around a part of tori's body acting as a fulcrum). It also allows learners to utilize the self-organizing tendencies of their bodies to find an individual solution for the task problem (successfully throwing the opponent). As Weers (1997c) proposed, understanding the basic throwing method allows a player to experiment and develop personal variation.

5.4.2 Pins

Pins are techniques that a judoka uses to hold the opponent down on their back. They are considered to be the most important of judo's ground techniques due to the fact that applying chokes or joint locks is close to impossible, if a player is unable to hold the opponent stable (Pedro 2001, 93). They have also been suggested to score points in competition more often than chokes or joint locks (Adam, Laskowski, Tabakow & Smaruj 2013).

Pedro (2001, 88) argues that pins are among the most strenuous techniques in judo, which may well be true, as it requires considerable effort to control the opponent for 20 seconds (the requirement for a score of ippon). As with throws, there are multiple distinctive pins, but to make understanding and learning them easier, Gleeson (1967, 149) proposes a division into three categories: pins performed from the direction of uke's side (e.g. yoko-shiho gatame), from the direction of uke's head (kami-shiho gatame) and on top of uke (tate-shiho gatame).

The classification is not necessarily comprehensive, but Gleeson (1967, 149) suggests that especially with beginners, it is useful. Whichever the type of pin, their aim is to keep the opponent on their back for 20 seconds, while keeping one's own body on top of the opponent's (IJF 2019).

There are multiple ways of escaping a pin, resulting from the rules that define osaekomi (the successful application of a pin) (IJF 2019). The defending player can either trap the opponent's leg or body with their legs, turn on their stomach, move the attacker off their body or apply a choke or a joint lock, although applying a choke or joint lock when in a pin, is close to impossible.

In essence, escaping a pin resembles chess, in that it relies on making an action and forcing the opponent to react to it (Bradic & Callan 2016). The opponent's reaction, in turn, creates new affordances that the player can utilize. In this way, the contest proceeds until the defender either escapes or the attacker succeeds in holding them down for the full 20 seconds.

5.4.3 Submissions

In judo, two types of submissions are allowed: chokes and joint locks to the elbow joint. Chokes are generally used to restrict blood flow to the brain as well as air flow to the lungs, although some of them also cause pain, which may lead to the opponent surrendering (Pedro 2001). A player can, thus, win by applying a choke and having the opponent submit by tapping twice or more with their hand (IJF 2019). Also, if a player loses consciousness when choked legally, the opponent wins (IJF 2019).

Chokes work by applying pressure to the opponent's neck and thus constricting blood and air flow (Pedro 2001, 96). A player can use various methods to apply the pressure, the most common being their arms and legs, as well as the opponents lapels. Defending against a choke that has already been applied is relatively difficult and it is often advisable to surrender rather than risk permanent injury (Gleeson 1967, 178; Pedro 2001, 96). The same is true with joint locks.

In judo competitions, joint locks are only allowed to be performed on the elbow joint (IJF 2019), which is generally possible in two different ways. In one method, a player uses parts of their body to lock the opponent's elbow joint straight and then keeps applying force to stretch it further (Pedro 2001, 107). Another way is to apply pressure to uke's arm when the elbow joint is in a 90-degree angle (Pedro 2001, 116).

6 PURPOSE OF THE STUDY AND THE RESEARCH QUESTIONS

The purpose of this study is to provide suggestions on how nonlinear pedagogy could be utilized in teaching judo skill. Although considerable evidence has been provided to suggest that nonlinear models of teaching motor skills are more efficient (i.a. Lee et al. 2014; Gray 2018; Nathan et al. 2017), traditional teaching methods are still widely used in combat sports (Körner & Staller 2017), as well as a wide range of other sports as well. In judo, there have been attempts to promote teaching methods that comply with current knowledge on skill acquisition. Gleeson (1967) proposed already in 1967 that teaching judo should be done from a more individual approach that accounts for and encourages inter- and intra-individual variation.

There is currently a lot of information on NLP and its effects have been studied in a wide range of sports such as tennis (Lee et al. 2014), baseball (Gray 2018), badminton (Nathan et al. 2017) and football (Práxedes et al. 2019). However, there have been relatively few attempts to apply it in combat sports, not to mention, specifically in judo.

Research questions. To provide insight into how the pedagogical principles of NLP should be applied in judo, this study aims to answer two fundamental questions:

1. How could judo be taught using NLP
2. What kind of principles would help practitioners apply the precepts of NLP in judo

Since there is almost no research on the application of NLP in judo, this study aims to provide a suggestion on how it might be done. However, using nonlinear pedagogy requires a different viewpoint on skill acquisition compared to a more traditional approach. Therefore, the study also aims at bridging that gap by creating concrete principles to help practitioners use NLP in their teaching.

7 RESEARCH MATERIAL AND METHODS

This is a quasi-experimental intervention study of how nonlinear pedagogy could be used in teaching judo skill. The intervention was conducted as part of the training sessions of an adult judo group in a judo club located in the capital region of Finland between September and December of 2019. It consisted of two 60-minute training sessions (excluding warm-up) per week, for a duration of ten weeks. The 20 hours training program was designed and implemented by the author of this study and its aim was to include a wide range of different aspects of judo, to provide insight on NLP's application in different learning contexts. Data was gathered by the author keeping a research diary on their observations of the training sessions. This chapter will discuss the design, implementation and observations of the intervention in detail.

7.1 Preparatory phase

The preparatory phase consisted of all the work that was done before the intervention was conducted. In essence, it included the planning, selecting the target group and designing the training program for that group. The planning started in September 2018 by deciding on a subject to study. Having been a judo coach for more than fifteen years, it was logical to study something related to it. Skill acquisition has also always interested me, therefore I chose to combine those two and study skill acquisition in judo. A review of studies conducted on skill acquisition in judo showed that there was a lack of scientific knowledge on the subject. Thus, I chose to conduct a study that would provide information on the subject, to act as a foundation for further studies.

7.1.1 Selecting the target group

After the study plan was established, the next step was to select the target group. Hulley, Newman and Cummings' (2013) suggestions that a target group should provide a suitable combination of generalizability and accessibility. Due to the double role of being the study author and the coach in the intervention, the location of the training sessions was a major factor in the decision. The dojo (judo gym) needed to be within an accessible distance in order to

allow travel to and from the training twice every week. Also, the amount of time available for coaching trainings was limited to two sessions per week.

Only using one target group inevitably leads to a relatively poor generalizability, thus, to improve it, a group with a wide range of participant age and skill level was preferable to a more uniform group. Therefore, an adult group was selected instead of a junior one. Adult groups tend to include learners from as young as 14 all the way to over 60 year-olds. Also, they often consist of participants with vast differences in skill level. To provide information on the application of NLP in a wide variety of context, a considerable amount of inter-individual variation in age and skill level was an important selection criterion for the group.

With the major selection criteria established, i.e. accessible and wide range of participant age and skill level, the Finnish Judo Association was consulted to find appropriate options for the actual study sample, i.e. the group that actually participates in the study (Hulley et al. 2013). Two possible options came up and the final decision was done between them. One of those possible groups needing a coach for the season resulted in them being selected as the actual study sample. The choice was also affected by the group not being strongly competition oriented. Since the versatility of the program was not suited to optimize competitive performance, the group was an ethical option. The ethics are further discussed later in this chapter. The final permission to conduct the study in the club in question was granted by the club's chairman.

The selected study group had fifteen participants (thirteen men and two women). The gender distribution is relatively typical in Finnish judo, women often being under-represented. There was a wide array of differing skill levels among participants, with the most experienced ones having practiced judo for more than 40 years and the least experienced having started one month before the intervention began. On average, the participants reported fourteen years of history practicing judo.

After the target group was selected, the participants were recruited individually from the group. After one of their training sessions the author provided them with information on the study as well as an approach letter (APPENDIX 1 & 2), the data protection announcement (APPENDIX 3 & 4) and a consent form for the study (APPENDIX 5 & 6). All the forms were provided either in Finnish or English, depending on the participant's preference. After their next training session, they were given a chance to ask further questions and sign the consent form if they

were willing to participate. In the case of participants younger than 18 years of age, the consent form was asked to be signed by a parent or a guardian in addition to themselves.

Due to several learners not attending the training sessions in question, the same information and hand-outs were provided to them when they attended for the first time. They were similarly given a period of time to familiarize themselves with the forms before providing an answer whether they wanted to participate or not. Every learner in the group chose to participate.

7.1.2 Intervention design

Normally, when designing a training program, it should be done based on a needs-analysis of the athlete or group in question. However, the study's aim to apply NLP in as wide a range of learning contexts in judo as possible presented a challenge. The first priority for the training program was to include a large number of different subjects, e.g. specific throws, pins, chokes and arm locks, tactical training such as how to create and utilize throwing opportunities and cognitive skills such as understanding the structure of a judo contest. The needs of the group were therefore only the second priority. In practice it meant that the subjects for all the sessions were designed to provide variety and each session was then designed to suit the target group. The outline for the training program can be found in APPENDIX 7.

Training program contents. The first part of designing the training program was the selection of the subjects for each of the 20 sessions. Points are scored in judo by applying successful techniques (IJF 2019), therefore specific techniques were selected as subjects for multiple sessions. At least one technique from each category, i.e. throws, pins, chokes and joint locks was used to allow the application of NLP in all the categories. Additionally, throws were further divided into two categories according to Sacripanti's (1987) classification and one throw from each category was used.

In accordance with NLP's pedagogical principle of representative learning design (Chow et al. 2016, 57), the techniques were taught in a relatively realistic situation, with both players trying to score. For example, throws were taught in pairs, so that during one session, players were taught both a certain throw and a counter to that throw. This enabled the use of contests where both players could fight to score, one by throwing and the other by countering the throw.

The teaching process was individualized so that each learner could practice at their own level. The participants' skill levels were classified into three categories based on Newell's (1986)

system and the goals for each session, and consequently for each task, were different for learners of each category. Therefore, even though the techniques remained the same for each class of learners, the tasks were different. For example, a throw would be taught differently for a learner who was already familiar with it than to someone who encountered it for the first time.

The method was always the same: a demonstration was performed by the coach, then the basic mechanics were explained according to Sacripanti's suggestions, i.e. how the throw works. Then the learners would be given tasks based on their skill level. Beginners would be given a task to perform the throw according to the basic mechanics they were shown. For example, o goshi would be taught by instructing beginners to place a fulcrum against uke's waist and rotate them over it. They would then receive implicit feedback on their success by analyzing whether they managed to successfully perform the throw.

Experts, in turn, would not necessarily benefit from such a simple task (Guadagnoli & Lee 2014). Instead they would be given more difficult tasks that would more closely represent the performance environment of randori and competition. Using the same example of o goshi, the task for experts could be to start without grips and perform the throw against an uke who tries to maintain distance between the players. Uke's effort would also be manipulated so that tori always had a chance of performing the throw successfully.

As mentioned earlier, specific techniques formed a part of the training program, however, the game of judo (Kozub & Kozub 2004) was also taught through tactical concepts. Those tactical concepts included such as posture, gripping and throwing opportunities. Similarly, to specific techniques, the concepts were taught by presenting the learners with appropriate task problems to solve. For example, throwing opportunities were taught according to Weers' (1997c) and Pohja's (2019) classification that was introduced earlier in chapter 3.

For example, the second throwing opportunity, where uke has their supporting foot "hidden" behind their center of mass was taught to beginners by giving them the task to find a situation where it is easiest to throw uke with o goshi. Their solutions usually had uke leaning forwards, which prompted the question of where uke's supporting foot was in regards to their center of mass. Again, such a task would be too easy for experts to facilitate optimal learning (Guadagnoli & Lee 2004). Instead they could be asked to find three different ways to create such an opportunity for throwing.

Once the outline for the training program was established, lesson plans were created for each lesson. A custom template was used for the lesson plans and it can be found in APPENDIX 8. The plans were designed by the author by combining theoretical knowledge on NLP and more than fifteen years of expertise in coaching judo, as well as from a degree in teaching physical education. However, the lack of empirical evidence on applying NLP specifically in judo meant that the plans were, in essence, simply one person's attempts to implement NLP in judo. To compensate for that, the lesson plans were constantly improved during the intervention, by adapting them based on the observations from already implemented lessons. The observation will be discussed further in a later sub-chapter.

The intervention was carried out in a judo club in the capital region of Finland between September and December 2019. The training sessions took place in the target group's own dojo (judo gym) and during their normal training hours twice every week for ten weeks. There was a one-week break due to a school holiday during which no trainings were organized at the club, which meant that the intervention lasted for eleven weeks in total.

Each training session started with a 30-minute warm-up that was not part of the actual study, followed by a 60-minute lesson according to the training program and lesson plan. Those 60-minute lessons were the actual study part of the sessions and were thus designed and coached according to NLP. The double role of being the coach and the study author presented a challenge since there was a need to both coach and observe simultaneously. Notes on the observations were taken during the lesson and later expanded upon after the session, the next day at the latest.

7.2 Observation for data collection

The primary method of gathering data in this study was observation during the training session, conducted by the author of the study. Observation was chosen since it is considered an appropriate method when there is little previous knowledge on the subject (Tuomi & Sarajärvi 2018, 70). In observational studies, the role of the observer is important (Connelly & Clandinin (1990). Due to the requirements of coaching according to NLP, it was not possible to use coaches who were not familiar with the method. Therefore, the author had to act as both the observer and the coach, giving the observation characteristics of participant observation (Tuomi & Sarajärvi 2018, 70; Vilkka 2018). It is a method where the researcher is an active agent as opposed to an external observer (Tuomi & Sarajärvi 2018, 71). In this study it meant that while

observing, the author also coached the training sessions, therefore actively affecting the participants and the outcome of the study. The researcher influence is discussed further later in this chapter.

After each session, research notes were written based on the observational findings from that session. In addition to taking notes on the gathered observational data, each session was also analyzed with Chow et al.'s (2016, 144) NLP session reflection tool, to discern whether the session adhered to the basic principles of NLP. Chow et al. (2016, 144) developed the reflection tool for just that purpose. They acknowledged that it is difficult to objectively judge whether one's coaching or teaching achieves certain criteria and therefore they developed a tool to help with that. The tool consists of statements on the central concepts of NLP and the practitioner's task is to consider each statement and write down notes regarding that statement. The NLP session reflection tool can be found in APPENDIX 9.

It took approximately 30 minutes to write down the research notes after each session. There were eight pages of research notes altogether when the font that was used was Times New Roman size 8 and each note was written on a separate line with the line spacing set as 1.5. Those eight pages of research notes formed the data that was analyzed and compared to the theoretical knowledge on the subject. The process of analysis is discussed next.

7.3 Analysis of research data

Content analysis (Tuomi & Sarajärvi 2018, 78) was used to analyze all the gathered data. Despite applying a focused observation method there was a relatively wide range of subjects represented in the notes. To facilitate the process of analysis, the research notes on the observational findings were classified into four categories: observation on teaching judo specifically, observations on teaching in general, observations on the study itself and observations on how the coaching seemed to succeed.

Observations on teaching judo specifically contained the observations of most interest for the study. Observations on teaching in general on the other hand were potentially useful but since the study was delimited to the specific application of NLP in judo, they were not utilized. Observations on the study itself, as well as observations on how the coaching seemed to succeed, were distinct categories that provided help for further lesson planning but were not used in the creation of the teaching principles.

Since this study focuses on applying NLP specifically in judo, the category of observations relating to teaching judo was the main interest. In accordance with Tuomi & Sarajärvi's (2018) suggestion, a clear delimitation was made that excluded the other categories.

After the classification of entries, the data was themed to provide an understandable basis to support the creation of practical principles for applying NLP in teaching judo. The themes are introduced next in this chapter.

NLP session reflection tool. Three themes were formed based on the notes from the statements of the NLP session reflection tool. The first theme was named "adapting teaching to suit individual needs" and it was formed from notes on the statement of "learning tasks match needs of the performer given the current status of the individual". The notes highlighted the problem of adapting the coaching to suit individual needs. They included such entries as "Mainly yes, but the needs of both extremes (experts and complete beginners) are not necessarily so well represented" (5.9.2019, session 2).

The second theme was named "simplification" and it was formed from notes on the statement of "learning task design simulates the performance environment through task simplification". The notes were varied and dealt with many aspects of simplification, e.g. how to simplify randori and how to maintain task representativeness while making them simple enough for learners. An example of the notes on this statement included such as "Randoris should have been simplified even more probably" (2.9.2019, session 1)

The third theme that clearly stood out was related to functional variation and was named "metastability". It was formed from notes on the statement "some parts of the session take students out of their comfort zone (creating metastability)". The notes highlighted the difficulty of creating metastability for learners when practising techniques. They included entries such as "More attention for this next time (with beginners, it's realized by itself, but with experts, good challenges must be thought of" (24.10.2019, session 16).

Observational findings. As mentioned before, the research notes included notes from the NLP session reflection tools (see above) and notes on the observational findings (presented here). Two themes ("realistic situations" and "tactical concepts"), and two remarks (introduced later in this subchapter) that related to themes from the NLP session reflection tool notes, were formed from the observational findings. The first theme was named "realistic situations" and was formed from multiple notes that emphasized the difficulty and the importance of teaching techniques in realistic situations (see representative learning design in chapter 3). The notes

acknowledged the need to use relatively non-representative tasks in the very early stage of learning but emphasized the need to progress to more representative tasks fast. They included entries such as “teaching a throw and a respective counter throw during the same session to provide more sense to practice games” (15.10.2019, session 12) and “pins always from a realistic situation” (17.10.2019, session 13).

The second theme was named “tactical concepts” and it was formed from entries that pointed out the importance of designing appropriate games to utilize implicit learning in teaching tactical concepts. Examples include remarks such as “- three rounds of fights where one tries to perform an uchi mata and the other tries to counter it”.

In addition to the two themes that were formed from multiple notes relating to the same subject, two minor remarks were made that were closely related to the themes created based on the NLP session reflection tool’s notes.

The first remark was a suggestion of incorporating short practice tasks in the training session to ensure athletes remain warm enough during more technical training sessions. The tasks would also provide a great opportunity for taking the athletes out of their comfort zone, i.e. creating metastability. The second remark considered the role of uke and suggested that it was an easily overlooked opportunity for adding variation, and also creating metastability, in the practice tasks.

After the themes were formed, they were next used to support the creation of practical principles for teaching judo according to NLP. Those principles are discussed in detail in the next chapter.

8 SIX PRINCIPLES FOR APPLYING NONLINEAR PEDAGOGY IN JUDO

As a result from this study, six principles were created to help practitioners apply NLP in their teaching in order to make it more effective. The principles have been derived from a synthesis of previous scientific knowledge and the research data from this study's intervention. The theoretical frameworks of NLP and judo, introduced in chapters one, two and three, act as a strong foundation underpinning the principles and providing them validity.

Combining the ideas of NLP and tactical learning approaches such as Kozub and Kozub's (2004), judo can be regarded as a game with the aim to score while preventing the opponent from scoring. Rules set the boundaries within which the game is played, and techniques act as tools to accomplish scoring.

The number of techniques an athlete is able to perform in competition has been shown to predict success in judo (Franchini, Sterkowicz, Meira, Gomes & Tani 2008; Weers 1997a). According to Weers (1997a) a world champion or olympic champion uses on average six different throws and two different ground techniques. Therefore, it is clear that teaching techniques efficiently is one of the key requirements for coaching a successful judo player.

As mentioned earlier, though, techniques are only tools with which to score. There are also other aspects of the game that affect performance, such as posture, movement and gripping for example. The principles in this chapter aim to provide practitioners with a tool to teach judo as a complete game, instead of a somewhat typical method of dividing it into techniques and randori.

8.1 Teach how a technique *works* - not how *it's done*

In NLP, an important principle is focusing on the movement outcome, instead of its pattern (Chow et al. 2016, 123). In a similar argument in the context of judo, Kelly and Weers (1997) suggested already in 1997 that not teaching the mechanics behind judo throws is a coaching error. Unfortunately, it's an error that is still often committed in the coaching circles. Kelly and Weers' (1997) and Chow et al.'s (2016, x) views can be regarded as a suggestion to teach what needs to happen in a technique instead of how it should be performed. In judo, biomechanics, i.e. the study of forces and their effects on humans in sport (McGinnis 2013), offers a suitable

solution to accomplish this. Sacripanti's (1987) classification of throws (introduced in chapter three) is a good example of this. The same approach should be used in teaching judo in general.

Techniques in judo - as well as other combat sports (Körner & Staller 2017) - are often taught by having the students reproduce a movement pattern shown by the coach. Presenting the students with an example is a good practice, but the problem lies in what information is given to facilitate the learning (Chow et al. 2016, 23). Traditionally, coaches and teachers have focused on the movement pattern instead of the outcome of the movement (Chow et al. 2016, 123). In judo such focus can be seen in instructions where the coach guides the students with specific information on how exactly they should arrange their body to perform the technique. Such instructions lead to students trying to replicate a movement without understanding the mechanics behind it.

Additionally, instructions on body part placement and action tend to lead to an internal focus of attention which - as discussed in the theory chapter- in turn may lead to less successful learning. The main problem on learning something via reproduction is the inherent variability in human movement. Even among elite athletes there is a high amount of inter- and intra-individual variability in movement patterns (Glazier & Davids 2005; Schöllhorn & Bauer 1998). Given that even an individual athlete can't reproduce two identical movements, it is not feasible to attempt copying a movement pattern from someone else.

Instead, a coach should provide instruction on the outcome of the movement (Chow et al. 2016, 123) and the mechanics behind it (Kelly & Weers 1997). For example, when teaching o goshi these are things a coach can emphasize: creating a fulcrum against uke's hips and rotating uke over it. Then through problem solving and questioning the coach can facilitate the students' learning of how to perform the throw effectively. They could, for example, encourage the students to try out different heights for placing the fulcrum and then ask what they thought was the best. Or they could tell the students to try throwing with uke leaning slightly forwards or backwards, or without leaning at all. After that they could again ask which one the student's thought was best.

Teaching in this manner encourages implicit learning which has been shown to lead to more durable movement patterns i.e. movement patterns that aren't as easily perturbed by intervening factors such as anxiety or surprising events (Button, MacMahon & Masters 2011; Masters 1992). This method of teaching also benefits the students' further learning. By understanding the mechanics behind a certain technique, they start recognizing the same principles in other

techniques as well (Kelly & Weers 1997). This mechanical approach also helps students understand what needs to happen in a technique for it to be successful. Therefore, they are able to perform an effective technique that is always suited to the current situation. Instead of learning a fixed set to perform the same technique by replicating someone else's version of it.

8.2 Train like you fight - representative practice tasks

Another consideration when teaching techniques is the environment that they are actually performed in, i.e. a contest in competition or randori training. Although practice task design should promote adaptability (Chow et al. 2016, 67) and represent the actual performance environment (Chow 2010; Chow et al. 2016), when observing judo being taught, it is common to see techniques, such as throws or pins, performed over and over against a neutral uke, with nothing to reflect the conditions in which it needs to be performed in. Often uke aren't given any instructions at all, rather they simply stand or lie in place and wait for tori to perform their technique.

It is true that this might be a competent practice task design for a certain stage of learning. For example, a learner who already knows the basic mechanics of a certain throw might benefit from such a practice task. They already know what position uke needs to be in to afford the throw as well as what they themselves need to do in order to successfully perform their throw. In this case the learner might benefit from a task where their objective is to manipulate a neutral uke to the "correct" position and then perform the throw.

However, for learners who either have not yet understood the basic mechanics or who alternatively have already mastered the above-mentioned stage, such a task is most probably not going to optimally promote learning or performance development. As Guadagnoli & Lee (2004) point out, there seems to exist a zone, or challenge point, where the task difficulty as well as the amount and the quality of available information are optimally suited to challenge the learner. According to them, training at the correct challenge point is optimally suited to promote learning. In light of their observations, it stands to reason that using the same, relatively static, training design perpetually and for learners in all the various stages of learning, is probably not the most effective way of teaching judo skill.

Instead, as mentioned before, practice tasks should be designed so that they closely relate to the actual performance environment and encourage learners to adapt their technique based on the

emergent situations. It could be argued that randori is designed to accomplish just that, and in a way it is. But randori is rarely even close to the optimal challenge point (Guadagnoli & Lee 2004) for optimal learning of a certain technique. It provides the learner with an often superfluous amount of sensory information and the resisting opponent sets the difficulty level too high. Those factors together usually lead to less than optimal learning which is why randori alone cannot be counted on to provide the representativeness and adaptability needed.

Therefore, technique training needs to be modified to provide the learner with tools and the ability to actually perform the techniques in randori. That can be accomplished by modifying the practice tasks to match their representativeness of the actual performance environment to the learner's stage of learning. Using the same example of teaching o goshi as before, this is how the practice task could be designed:

Tori and uke should both be given a task that represents a realistic action in a competition setting. Usually uke's task would be some kind of an action that makes tori's successful performance more difficult. However, with beginners, uke's task should be something that facilitates the success of the technique. In this case it could be to lean or push forwards for example. Such an action is realistic - i.e. you will see contestants pushing and leaning forwards in competition - and it provides tori with an opportunity to throw. In addition to facilitating successful throwing, the task design also teaches the learners to recognize and utilize actual throwing opportunities.

When the learners have mastered the stage of throwing a co-operating uke, the practice tasks should progress closer to the actual performance environment. Uke should start making tori's task harder, because that is what players do in a competition. With intermediate players, uke could for example be given the task to "step over" tori's hips to prevent the throw from being successful. Tori in turn would have the task to counter uke's evasive movement. Such a task would help tori overcome a common problem with the throw, i.e. not placing the fulcrum (their hips) properly to rotate uke over them. Uke on the other hand would learn a possible evasion, and a prerequisite for certain counter throws, for the throw.

When learners' skill level increases further, the practice tasks should increase in difficulty and grow even closer to a competition setting. Tori's task could be to perform o goshi, starting from a neutral position without grips. At the same time uke's task could be to counter tori's attack with tani otoshi (given that they already know that throw). This task would be relatively highly representative of competition but can still be modified to make it more, or less complex

depending on the needs of the learners. If one learner were less skilled for example, they could be allowed a wider variety of throws or counter throws to even out the contest. As uke, the less skilled player could, for example, be given the task to simply avoid the throw for a certain time by any legal means.

Selecting or designing the tasks to ensure efficient learning is the most difficult part in this method of teaching. Studies suggest that it might be effective to design the tasks to guide the learners' attention towards common errors that prevent the successful execution of the technique (Prieto, Gutierrez, Camerino & Anguera 2013; 2016). The example used before, where uke side steps an o goshi, is a good example of this. Although Prieto et al. (2013; 2016) focused on tori's errors instead of uke's evasions, their suggestion of focusing on errors seems to be supported by nonlinear pedagogy. By instructing uke to react in a realistic way and forcing tori to adapt their technique accordingly, or alternatively by instructing tori to try out different variations of a technique, learners can be encouraged to explore their perceptual-motor workspace in order to find appropriate individual solutions to performing techniques.

The difficulty in this method is to recognize the fundamental errors that prevent the success of a technique. Therefore, the coach's task is to find the common occurrences that prevent the successful execution of a technique and then incorporate them in practice tasks to allow players to adapt their performance accordingly. As long as the occurrences in question are picked out in the actual performance environment (i.e. randori training or competition), applying them in a practice task would increase that task's representativeness.

8.3 Simplification - controlling the tactical complexity of judo

As mentioned before, judo is traditionally taught by first teaching techniques and then having learners engage in randori to try applying those techniques in order to score. However, a judo contest is tactically extremely complex. The number of possible ways to throw your opponent is vast. Not to mention all the ways to win the match on the ground or with penalties. Regardless of its complexity, it is common to use randori as a form of training even among beginners. However, according to some experts, it is advisable to start with simpler games and gradually work towards more complex ones when the goal is to ensure that the learners understand the game (Thorpe & Bunker 1989; Thorpe, Bunker & Almond 1984). It also stands to reason that a complex game like judo presents a beginner with an amount of information that easily overwhelms them. To prevent that, it is advisable to design simpler practice games that match

the learners' skill level (Chow et al. 2016, 165) while still maintaining the relevant tactical problems of the actual game of judo.

The practice games can be very similar to a traditional randori where both players have a similar goal or they can be variations of it where the task for both players is different. Randori represents one end of the spectrum, with very little simplifications made compared to an actual contest. On the other end of the spectrum are common practice tasks where one player is trying to apply a technique, e.g. a throw or a pin, and the other tries to prevent it. The coach's mission is to design appropriate games to teach specific aspects of the game. The crucial consideration when designing games for learners in judo, is the amount of information the learner must process when playing it. While an expert is able to distinguish the relevant information from all the non-essential even when engaging in regular randori, a beginner is not. Therefore it is the coach's responsibility to simplify the game to have it match the learner's skill level.

In essence, simplifying randori only requires rule changes that limit the number of possible situations the players face. The following modifications, among others, can be used to accomplish that: forbidding counter throws, allowing only certain grips and techniques or dictating the ways the players are allowed to move. For example, a good game for beginners is sumo wrestling where the goal is to remove the other player from inside a play area. That game is helpful in teaching good posture and the utilisation of the opponent's force in moving them.

To make the games appropriate for more advanced players, more elements can be added to more closely resemble regular randori. For example, one aspect of judo that makes it difficult is the speed with which the situations change. To help players cope with the speed, the "Stop-game" can be used. In that game, a player is allowed to freeze the situation during randori by calling out the name of a technique. That player is then allowed time to perform that technique. The process of freezing the match leads to players actively searching for affordances and learning to utilise them.

Regardless of how much randori is simplified, as long as both players have similar roles, the number of actual attack attempts often remains low. Practising a specific technique or concept, such as manipulating uke's posture to create an affordance for throwing, that way is often inefficient due to the low number of repetitions.

A good method of teaching a specific technique or concept is to use games where the players' roles are different from each other, like in the simplest game forms mentioned earlier, e.g. a game where one player has the task to attack with o goshi (a forward throw) and ko uchi gari

(a backward throw) and the other player's task is to defend against them for a certain amount of time. The attacking player learns to combine techniques and feints (switching directions of attack quickly to surprise the opponent) and the defending player learns to evade and defend against attacks.

8.4 Individualization: same technique - various difficulties

As mentioned in the previous sub-chapter, the methods of practising a skill should differ based on the skill level of the learner. Chow et al. (2016, 147) suggest designing task goals based on three stages of learning: beginner, intermediate and advanced. Their suggestion is useful for judo coaches dealing with the challenge of coaching a group including individuals of varied levels of skill. The idea behind their notion is not to devise three completely different lesson plans, but rather to adapt the tasks so that every learner can practice them at their own level.

Designing the task goals separately for the three stages of learning is simple. In essence it requires the coach to consider what they would like to see from each group of learners at the end of the lesson (Chow et al. 2016, 147). Determining appropriate task goals is made easier by thoroughly understanding the skill in question and dividing the ways to execute it based on their difficulty. An example of this is presented in Table 1. The example is not meant to be comprehensive, rather it is used to clarify the process of modifying task difficulty while maintaining its theme i.e. the technique in question.

TABLE 1. Conditions of executing a throw divided based on the task difficulty starting from the easiest.

Conditions of executing the throw
No movement; uke leaning towards the direction of the throw
No movement; uke standing in neutral posture
No movement; uke leaning away from the direction of the throw
Throw; uke uses specific evasion if possible; throw again and adapt for the evasion
Grip and move uke to create opportunity for the throw
Grip and apply force to uke; uke either resists or moves with the force; utilize their reaction to throw
Grip; feint with another throw in the opposite direction; utilize uke's reaction to throw
Uke grips first; fight for your preferred grip; move uke to create opportunity for the throw
Uke grips first; fight for you preferred grip; feint in opposite direction; use uke's reaction to throw
Uke attacks; defend and use your throw to counter the attack
Uke attacks; evade their attack; take your preferred grip; move uke and throw
Start with no grips; uke's task to evade your throw; doesn't know which throw
Start with no grips; uke's task to evade your throw; knows which throw

The list is not comprehensive and the order is argumentative

This concept, while useful, can become arduous for the coach if they have to pick a suitable task for each learner. One option of lightening the load is to leave the task selection to the learners, especially in the case of advanced players. A good way of accomplishing that is to create a suitable list and make it available during practice using e.g. a whiteboard. That way the coach can concentrate on observing and providing assistance. Another benefit of such a method is that it provides variation.

There is another factor that affects task difficulty, usually inadvertently, and should also be considered. That factor is the uke. Every judo player faces a situation at some point where they're training with an uke whom it seems impossible to throw. It is an inconvenient situation since it makes the task drastically more difficult and it's not always easy, especially for beginners, to distinguish uke's effect from their own inability to perform the throw. It is therefore important for coaches to recognize learners who have difficulties in acting as uke and help them overcome those obstacles.

There are numerous factors that can cause learners to develop negative habits as an uke. Probably the most common reason is the fear or dislike of getting thrown. It is especially counter-productive since the more uke resists, the more uncomfortable the throw most often becomes for them. One way to assuage the fear of getting thrown is to simply use an extra mattress when first practising throws and then gradually move on to performing throws on the tatami. Judo is a co-operative sport and tori can also affect uke's fear either positively or negatively. Often it is advisable to partner fearful players with players who are experienced enough to perform their throws comfortably. That in itself can help learners overcome their fear.

Uke's role should also be taught and its importance highlighted regularly to facilitate the players learning to be better ukes. That in turn potentially results in players who learn to throw better. One example of a simple exercise to facilitate better performance as uke is the "easy-to-throw contest". It is a task where each player takes a turn throwing and getting thrown by everyone else and rates everyone's performance as uke. It might not be prudent to announce the ratings, rather have everyone do it silently. Simply the knowledge that everyone is evaluating their performance as uke often leads to improved performance. At the start of the task it could be useful to remind the players of the key aspects of being a good uke, i.e. avoid bending from the hips, stand in a neutral posture or lean slightly towards the throw and "go with the throw".

The role of uke and its possible negative effects to the practice of techniques, especially throws might seem obvious, but it is worth mentioning when considering the modification of technique difficulty. It is nearly useless to try modifying the technique difficulty by different variations if the person getting thrown resists when they're not supposed to. In that case it might be more useful to reduce the technique difficulty and focus on uke's performance.

When learning techniques without using a game-aspect, i.e. both players attempting to score simultaneously, it is often preferable to train with a partner who is experienced since it is often easier to perform throws successfully against them. However, the partner's role is slightly different, although equally important, when engaging in practice games.

It is a common occurrence for most judo players to engage in randori with someone whose skill level is either significantly higher or lower than their own. Regardless of whether the activity is a simplified version of randori or one without modifications they are always somewhat problematic.

It could be argued that the weaker player deserves to lose, and learning to deal with that loss is even beneficial. While it is true that judo can facilitate emotional growth, the ultimate goal when teaching judo should be to improve the learners' performance in judo. Although that opinion could be contested, especially when it comes to coaching children, for the purpose of this work, the main goal is considered to be the development of judo skill.

When two players with uneven skill levels compete against each other, it is questionable whether either player gains optimal learning benefits. The better player will probably be able to perform a high number of attacks, which in some cases is exactly what that player needs to develop their performance. However, it is also possible that the lack of challenge results in less-than optimal learning (Guadagnoli & Lee 2004). If the other player is unable to put up any significant resistance, it is likely that the task is too easy for the better player to facilitate optimal learning (Guadagnoli & Lee 2004).

The situation is not necessarily desirable for the weaker player, either. When competing against someone who is significantly better, the chances of being able to perform successful techniques is extremely low. As are the chances of successfully defending as well. According to Guadagnoli and Lee's (2004) theory, the challenge point for the weaker player is also not optimal. Where with the better player the task was too easy to provide challenge and therefore optimal learning, with the weaker player it is too difficult, with the same result. Tasks that are

too difficult also affect the learner's perceived competence negatively, which in turn weakens their motivation (Deci & Ryan 2000; Ryan & Deci 2000).

Experienced players often have various methods of coping with these situations. They might lower their own effort, thus presenting the weaker player with opportunities to attack and defend successfully; or they may stop attacking altogether and concentrate on teaching instead. Both of those methods are valid ways of dealing with unevenly matched players, but they both result in the better player being unable to actually play the game properly. While it isn't necessarily a negative thing as a single occurrence, it may become a real obstacle for learning if it turns into a permanent situation. It especially concerns players who are more skillful than others in the same group and thus lack evenly matched training partners.

Scaling is a term that refers to task and equipment modification in order to promote skill acquisition (Davids et al. 2008, 144; Farrow & Machar 2010). A good example of this is the usage of body-scaled equipment for children in tennis (Farrow & Machar 2010). The same principle can be used to modify games in judo to promote the learning of both players. The common dilemma of unevenly matched opponents can be solved by scaling. By modifying the rules, the task can be made more difficult for the better player while also making it easier for the weaker player. There are various ways to accomplish this, and it is recommended for coaches to use their expertise to constantly vary the ones they use and to create new ones.

One simple example is the introduction of a smaller play area for the better player. If they leave the area, the other player gets a point equal to a successful throw. By making the area small enough, the better player will face a real challenge in staying in and still throwing their opponent. While the better player needs to resist being pushed and pulled outside the area, their opponent can be encouraged to utilize those reactions by attacking in their direction.

Another good example is the introduction of "the freeze-card" for the weaker player. It allows them to freeze the situation at any point they want and then grants them a desired amount of seconds to attack while their opponent remains "frozen". Other possibilities include such as the limiting of techniques, grips and directions of attack.

It is important to note that the idea of scaling is not to completely replace traditional randori. It should be used as one more tool to add variation and combat the negative effects of uneven training partners.

8.5 Teach gripping as a system

Gripping is a fundamental skill in judo and experts such as Adams (1992), Pedro (2019) and Weers (1997b) emphasize their importance for every judo player. As Weers (1997b) stated, gripping essentially determines a player's ability to attack and defend. In a game of scoring and preventing the opponent from scoring, as Kozub and Kozub (2004) described judo, gripping is therefore a crucial part of judo.

"Get a grip" is a common phrase that coaches use to urge their athletes to grip the opponent in competition (Pedro 2019). Unfortunately the phrase carries very little useful information. Given the nature of judo, an athlete in competition is extremely unlikely to be unaware of the fact that they need a grip to throw the other player. Instead of calling out platitudes, coaches should teach gripping as more than simply tricks, trips and traps to catch the opponent's sleeve or lapel (Weers 1997a).

As Weers (1997a) points out, those tricks might work at lower levels but higher level players all have tricks as well. Therefore he maintains that the foundations of gripping dominance should be taught already to beginners. The world-famous judo coach and former world champion, Jimmy Pedro seems to agree with Weers' point when he describes the goal of grip fighting as always having a better grip than your opponent (Pedro 2019). According to him, the way to accomplish that is to constantly be one step ahead of your opponent in asserting your grips. Additionally, whenever you find yourself in an inferior grip situation, get out of it fast; either by breaking the opponent's grips or by attacking. There are undoubtedly a huge number of differing opinions on how to fight for grips in the best manner and the aim here is not to propose what grips to take in each possible scenario. Rather the goal is to offer ideas on how best to teach gripping.

Following Weers' (1997a) and Pedro's (2019) ideas, grip fighting should be taught as a system. Meaning that instead of over-simplifying gripping into single movements to catch an opponent's sleeve or lapel, players should be taught gripping as the dynamic system that it is (Calmet, Miarka & Franchini 2010). Simply teaching one sequence to get a preferred grip in any situation, coaches should acknowledge the fact that the situation is different in each match and a player should be able to adapt their gripping accordingly.

An important aspect of the match when deciding how to grip, is the stance situation of the athletes (Pedro 2019). As mentioned in chapter 3, ai yotsu and kenka yotsu are the most common ones (Courel et al. 2014; Weers 1997a) and should therefore be emphasized when teaching gripping. Players should be taught the goal of each situation and how to get there.

According to Pedro (2019) and Weers (1997a), and supported by the findings of Courel et al. (2014), the goal should always be to dominate the gripping in order to control the match and increase one's chances of scoring. Essentially the way to do that is to secure one's own power hand on the opponent's lapel and the pulling hand on their sleeve while preventing them from gripping you (Pedro 2019).

However, as is the nature of judo, achieving that goal is difficult because the other player is trying to do the same thing. That is why a simple trick to get a lapel or sleeve grip is not enough. Players should instead be taught a complete system. First they should analyze their own stance: are they a right- or a left-sided judo player. Pedro (2019) even suggests that a player should choose one side and always keep to it. After knowing their own stance they should analyze the opponent's in the same way: righty or lefty. That analysis tells them whether they're fighting in ai yotsu or kenka yotsu which in turn gives them the information they need to decide on how to approach gripping.

For example, according to Pedro (2019) in ai yotsu a player should always try to grip the opponents power hand by the end of the sleeve and push it down. Then secure a grip with their own power hand on the opponent's lapel. If they fail to get the sleeve grip they should instead use the hand and post it on the opponent's shoulder instead of taking their own power hand grip. His rationale for this is that having only the power hand on the opponent doesn't enable the player to prevent the opponent turning in for a throw. That is, assuming the opponent turns in the same direction as their grips, which according to Courel et al. (2014) is the most successful way of throwing.

Pedro's (2019) suggestions on what specific grips to take and when are only one possible option. However his method of approaching gripping is highly systematic which may be beneficial. A systematic approach to gripping means that players should be taught a system where they know what grips they want and how to get them. Additionally, they need to learn what to do when the opponent starts resisting. The process could be something like this in ai yotsu: *Try to capture the opponent's sleeve with your pulling hand. The opponent pulls that sleeve backwards to prevent it from getting caught. Then post the pulling hand on the opponent's lapel instead. If they grab that sleeve with their power hand, grab it with your own power hand, let go of the lapel with the pulling hand and move it to grab the opponent's sleeve, pushing the hand down. Then grab the opponent's other lape with your power hand.*

That is one example of what part of the gripping system could look like. It is not "the correct way" but simply one option. The important thing is that players are taught to understand how, and more importantly why, they should grip in any situation. Understanding the game of gripping is what allows them to adapt their own play according to the situation in question. That is crucial given that each match in judo is different, which is exactly why Weers (1997a) may be correct in discouraging the use of solely tricks and traps to secure your grip.

A gripping system is unfortunately not enough to win a match. That is why it is important to understand the relationship between gripping and scoring. The dominant grip that the players are striving for allows a powerful execution of throws (Weers 1997a), but achieving dominance is difficult because the other player will constantly try to break the grips to prevent being dominated (Courel et al. 2014; Weers et al. 1997a). That is why it is crucial to prepare attacks for every gripping situation you might end up in (Pedro 2019). Whatever the specific sequence of gripping that athletes use, it needs to include attacks from all stages of it.

Using the previously mentioned sequence from ai yotsu, the player should be able to execute a throw when they get the first sleeve grip with their pulling hand. If they didn't get the sleeve, they'd post the hand on the opponent's lapel. They need to know how to throw from there as well. Using this same logic, all the possible situations should be analyzed and throws should be trained for them. Then it is up to the player to apply that sequence in a match as they deem appropriate. Even the consideration of how to adapt that sequence in each match is something a coach should teach their athletes.

Using the principle of simplification, gripping shouldn't only be taught by engaging in randori and hoping that the correct sequence of gripping emerges. Instead it should be treated as a technique in the beginning, meaning that athletes should start practicing it in relative isolation. For example, beginners could be shown the sequence from the previous example, starting with capturing the sleeve and then securing the power hand on the opponent's lapel. After a few tries uke could be encouraged to resist in a realistic manner by trying to lift the hand up to grip tori's lapel. In this phase it is important to have uke only resist with very low effort, to present tori with the realistic information needed to adapt their performance but without making it too difficult.

When that basic sequence has been learned, players should be taught attacks from the sleeve grip and the end situation of a dominant two-handed grip. Later, the players would be taught to resist the dominance by preventing and breaking grips. Then would be an opportune moment

to introduce games where both players strive for a dominant grip. The process could then be continued by teaching the sequence further by adding ways for uke to resist and tori to counter the resistance. Weers (1997b) also suggests that throws should always be performed with a gripping sequence. Meaning that when performing repeated throws, players should always first apply a realistic gripping sequence and execute the throw from that grip. Teaching gripping in this manner facilitates the development of grip-dominant players which in turn potentially leads to success.

The examples used here have regarded standing-up situations but to a certain degree the same principles apply on the ground as well, although there the variety of grips is a lot wider. Regardless of the wide variety, the process is the same: analyze the situation, know your goal and how to reach it and finally adapt your play based on how the opponent reacts. The process on the ground is slightly different, though, because there the grips are more strongly integrated into the actual techniques. In standing-up situations a player, especially in high level competitions (Calmet et al. 2010), will usually fight for a dominant grip and immediately when they get it, launch an attack from those grips. Whereas on the ground a technique, e.g. a pass from half guard, will take longer and contain more phases where the player will change grips to facilitate the next phase.

8.6 Encourage problem solving by asking questions

As mentioned earlier, verbal information plays a key role in nonlinear pedagogy and coaches should therefore be aware of what they say and why (Chow et al. 2016, 120-121). Traditionally, coaches provide information in the form of instructions and feedback in a prescriptive manner, i.e. they tell the learners what to do, how to do it and how they performed. In nonlinear pedagogy, however, coaches are encouraged to take a more facilitative role (Chow et al. 2016, 122; Kalaja 2018), meaning that they manipulate constraints and provide information with the goal of letting the learners solve the task problems themselves via exploration and self-organisation (Chow et al. 2016, 122; Kalaja 2018).

The previous principles were focused on how to construct the practice tasks. This final principle gives instructions on how to present the tasks and guide the learners through them. In practice it means that coaches should design practice tasks according to the principles mentioned earlier and then present that task as a problem to be solved and guide the learning process via reflective questioning. In practice, the process is not very complicated.

Using the same example of teaching o goshi, the process would start by understanding the mechanics of it, i.e. creating a fulcrum against uke and rotating them over it (Sacripanti 2008). The next step would be to design a representative practice task and prepare modifications based on the learner's skill level. For this example, we'll assume that the learners are beginners who have never heard of this particular throw before. The objective could then be to rotate uke over tori's hips, ending with them on their back on the ground, i.e. perform a successful o goshi. A good practice task in this case would be to have tori performing throws with uke leaning forwards to facilitate successful throws. The next step is what this principle is concerned with: how to present the task to the learners and guide their learning to ensure optimal performance benefits.

As nonlinear pedagogy relies on the fact that optimal movement patterns for specific movements don't exist (Chow et al. 2016, 123), the role of a traditional expert demonstration of a skill is regarded differently than in traditional coaching. Especially in the early stages of learning, visual demonstrations are clearly beneficial. Schoenfelder-Zohdi (1992) studied the informational nature of a visual demonstration by an expert and found that using an expert model shortens the time it takes beginners to achieve a level of learning where they can perform a rough version of the skill in question. Davids et al. (2008, 198) explained that benefit to learning by the demonstration directing the learners' search of the perceptual-motor workspace. Similarly, Kalaja (2016, 237) explains the beneficial nature of expert demonstration by the provision of an idea of the skill the learners are practising.

Thus, it is advisable to start teaching a skill by providing a visual demonstration of it. It is of paramount importance, however, to note that the demonstration should not be used as simply a model to replicate. Rather it should be seen as a chance to outline the skill for the learners.

After the visual demonstration the next step is to present the learners with a task. As stated earlier, learning can be seen as a process of seeking and assembling a functional movement solution to given task constraints (Goldfield 2000; Rosengren, Savelsbergh & van der Kamp 2003). Therefore the task should be presented in the form of a problem to be solved, thus giving the learners the opportunity to explore their perceptual-motor workspace in order to find a functional movement solution.

When teaching new techniques, the main focus is in performing it successfully. The logical way of framing the problem in such circumstances would be to use the biomechanical description of the technique. For example, in the case of teaching o goshi for beginners, the task could be

presented as creating a fulcrum against uke's body and rotating them over it. With the visual demonstration and the problem to be solved, the learners would then be given time to try out different solutions.

The coach's role after getting the learners practising is to guide their search for functional movement patterns. Instead of pointing out errors and prescribing corrections, the coach should focus on helping the learners solve the problems through self-organisation by helping them direct their search. It requires evaluating their performance, identifying the possible errors and then directing their attention to the specific phase of the movement that requires improvement.

In the example of o goshi, one common problem for beginners is uke sliding around tori's hips, instead of over them. After identifying the problem the coach could use questions to increase the learner's awareness of their performance (Chow et al. 2016, 150). The questions could be e.g. "How would you say uke moved in regards to your hips?" or "Would you say uke rotated over your hips or around them?".

Those questions alone might help the learner focus their attention but an additional cue is often beneficial. A coach could for example advise the learner to feel for the moment when their hips make contact with uke and mark that moment by calling out "hips". Then they would be advised to feel for the sensation of uke moving against their hips and call out "over". The use of an analogy as described helps direct the learners to pay attention to relevant and external sources of information (Chow et al. 2016, 124) instead of having their mind wander or fixate on an internal focus.

9 CONCLUSIONS

This study aimed at ascertaining how judo could be taught using nonlinear pedagogy. More precisely, the goal was to create concrete, judo specific, principles that practitioners could use to help them apply NLP in their coaching.

The theoretical framework of NLP was first applied in the creation of a training program for a wide variety of judo skills. Then an intervention was conducted to execute that training program under observation. Then the research notes on the observation, together with scientific literature on NLP, acted as a basis for the creation of six principles for the application of nonlinear pedagogy in teaching judo. The principles are as follows: 1. teach how a technique works, not how it's done; 2. train like you fight; 3.simplification; 4. individualization; 5. teach gripping as a system; 6. encourage problem solving by asking questions. Those six principles combine the theoretical knowledge of nonlinear pedagogy and judo to establish a theoretically sound, but at the same time simple to use, framework for teaching judo.

The principles expand the existing knowledge of NLP by adapting its key principles in the context of judo. Although there is considerable evidence on NLP's efficacy in teaching motor skills (Lee et al. 2014; Gray 2018; Nathan et al. 2017) and tactics (i.a. Práxedes et al. 2019), there has been very little research on its application in combat sports. However, this study does not provide concrete findings, rather an insight into how NLP could be utilized in teaching combat sports and, more specifically, judo.

9.1 Trustworthiness

Instead of the quality criteria of quantitative research, i.e. internal validity, generalizability, reliability and objectivity, to judge the trustworthiness of qualitative research, Korstjens & Moser (2018) propose that Lincoln & Guba's (1985, 71) criteria of credibility, transferability, dependability and confirmability are more suitable for the task.

Credibility. Korstjens & Moser (2018), based on Lincoln & Guba (1985), define credibility as the confidence that can be placed in the study's results. They propose that it establishes whether the conclusions and interpretations can be considered valid. In this study, the strategies of prolonged engagement and persistent observations (Korstjens & Moser 2018) were used to

improve its credibility. Korstjens and Moser (2018) define prolonged engagement as "- long lasting engagement in the field with participants" and "investing sufficient time to become familiar with the setting and context -". In this study, the author's considerable history as a judo coach and their studies in NLP may be considered as sufficiently familiarising them with the setting. Similarly, the relatively close relationship of coach and athlete during the 20 hours of active observation, could be considered as long lasting engagement with participants.

On the other hand, triangulation, i.e. using multiple data sources, investigators and methods of data collection, was not used, which can be considered to impact the credibility of this study negatively. Although, concerning the possibility of using multiple investigators, there are relatively few candidates who are sufficiently competent both in the field of judo and NLP.

Transferability. Transferability determines the degree to which the results can be transferred to other settings (Korstjens & Moser 2018). Korstjens & Moser (2018) suggest that the judgment of transferability is not the author's responsibility, rather they should facilitate the judgment of a reader by using what they call "thick description". They define thick description as the accurate description of the participants and the research process. Based on the accurate description, readers can make well-informed judgments of transferability to their specific contexts. In accordance with their suggestions, the descriptions in this study have been written as accurately as possible to help readers evaluate this study's transferability.

Dependability and confirmability. Lincoln & Guba (1985) propose that dependability includes the aspect of consistency, meaning that researchers should ensure that their analysis process is in line with the accepted standards of their field. Confirmability, on the other hand concerns the aspect of neutrality (Lincoln & Guba 1985), which means that the interpretations should not be based on a researcher's subjective opinions, rather they should be grounded in the data (Korstjens & Moser 2018). Korstjens & Moser (2018) propose an "audit trail" as a strategy to ensure both dependability and confirmability. They describe it as the process of transparently describing all the stages of the research.

In this study all the steps have been described transparently, which should positively impact its dependability and confirmability. On the other hand, since only one researcher was used to provide all the interpretations, it is notable that another person might have interpreted the data differently. However, the interpretations were grounded in the theory of NLP, as opposed to being subjective opinions, which potentially improves the confirmability.

9.2 Ethical considerations

Tuomi and Sarajärvi (2018, 109) point out the importance of ethical considerations in qualitative research. They argue that the relatively unrestricted methods of gathering data require thorough ethical considerations. This study can be seen to epitomize their idea since all the information provided by this study is dependent on, and created by, the author. Therefore careful ethical examination was conducted to maximize the scientific value of the provided information. There were several aspects that prompted consideration and affected the study execution.

The first aspect dealt with training program suitability for the target group. Since the program needed to consist of as wide a range of subjects as possible in order to provide information on NLP application in various learning contexts, its benefits to the participants could be questioned. Especially with goal-oriented participants aiming to succeed in competition, 20 training sessions that aren't specifically designed to optimize performance might be seen as unacceptable. There were two groups that were considered for the actual target group and the less competition-oriented was chosen to minimize the negative impact that the study might have on the participants.

The recruitment of the subjects was also considered from an ethical point of view. The actual target group was one that the author had previously coached, which means that most of the participants were already familiar with the author. As Lo and Grady (2013) suggest, the familiarity leads to an increased importance of presenting the study fairly, since there may be conflicting interests as the participants' coach and as a researcher. To ensure the fair conveyance of information, the study was first introduced to the potential participants in person, after which they were given additional information to familiarize themselves with for three days. At their next training, in three days, they were given a chance to ask more questions before deciding whether they wanted to participate or not. The hand-outs that they were given can be found in APPENDIXES 1-6. To minimize possible misunderstandings, all the participants were also asked what language they would like to receive the information in. Both Finnish and English were used to convey the information, both in person and in writing.

The author's role in the judo club that the intervention was conducted in, also brought about a second ethical question, i.e. how to relate to the study after it is finished. In order to distinguish the roles of researcher and coach from each other, Vilkka's (2018, x) suggestion was followed.

She proposed that when interacting with participants after the study, the subject should not be approached unless specifically asked about it. Even then, care should be taken when discussing the subject.

9.3 In conclusion

The results of this study (i.e. the six principles for applying NLP in teaching judo) provide a concrete tool for practitioners to develop their teaching methods in accordance with current scientific knowledge on skill acquisition. The results suggest that NLP is potentially an effective teaching method for judo but since this study is among the first in researching this subject, the results are subject to a certain amount of uncertainty. Therefore, further research is needed.

A logical next step would be to construct a training program according to these principles and conduct a study to test its efficacy. It might also prove useful to first attempt to recreate this study to see whether another researcher, or a research team, would end up with similar guidelines or not. In that case, it may be worth consideration to videotape the training sessions to improve the reliability of the observation by enabling the researcher to focus on only coaching during the session. Given that the principles are found effective, a potential research subject would also be to compare the efficacy of a traditional training program to one that is constructed following these principles.

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APPENDICES

Appendix 1. Approach letter

A TRAINING PROGRAM FOR JUDO ACCORDING TO NONLINEAR PEDAGOGY

I study sport sciences in Jyväskylä University and am doing my master's thesis on teaching judo. The group that you are training in has been chosen to take part in the study and I hope you would consent to participate. Participation doesn't require anything more than taking part in the trainings as usual.

The purpose of this study is to create a training program for teaching judo that is based on the current scientific evidence on skill acquisition. Nonlinear pedagogy is the name of a theoretical framework that offers a basis for skill acquisition, based on strong scientific evidence. Despite its complicated name, nonlinear pedagogy is not complicated or special. It is simply a teaching method that takes into consideration the current scientific evidence on the subject.

The trainings will take place as usual and no radical changes will be made. There will be certain modifications to previous teaching methods, but nothing that should worry the participants. The most notable change will be in the structure of the trainings: where before there would have been separate skill and randori parts of the training, they are now going to happen simultaneously.

While conducting this study, ethical guidelines will be strictly adhered to. Those guidelines include among others, every participant's information security. During the study, basic information will be gathered from participants. That information icludes, but is not limited to, age, gender, judo training history and belt color. Information is stored according to information security legislation. More information can be found on the data protection announcement.

I hope you will participate in the study! If there are any questions, feel free to ask.

With respect,
Lauri Särkilahti
[redacted]

Appendix 2. Lähestymiskirje

NONLINEAARISEN PEDAGOGIIKAN MUKAINEN HARJOITUSOHJELMA JUDOON

Hyvä judon harrastaja tai harrastajan huoltaja!

Opiskelen liikuntatieteitä Jyväskylän yliopistossa ja olen tekemässä pro gradu -tutkimusta judon opettamisesta. Ryhmä, jossa harrastat judoa, on valittu mukaan tutkimukseen ja toivoisin, että suostutte osallistumaan tutkimukseen. Tutkimukseen osallistuminen ei vaadi teiltä mitään normaaleista harjoituksista poikkeavaa. Kaikki toiminta tapahtuu normaalien harjoitusten puitteissa.

Tutkimuksen tarkoitus on luoda nykyaikaisen taidon oppimiskäsityksen mukainen harjoitusohjelma judon opettamiseen. Nonlineaarien pedagogiikka on nimitys teoreettiselle viitekehykselle, joka tarjoaa vahvaan tieteellisen tietoon pohjautuvan perustan taidon opettamiselle. Erikoisesta nimestään huolimatta nonlineaarinen pedagogiikka ei ole mitenkään monimutkaista tai erikoista. Siinä on koottu yhteen tämän hetkinen tieteellinen näyttö taidon oppimisesta, minkä pohjalta on luotu periaatteet opettamiselle.

Harjoittelu tapahtuu aivan kuten ennenkin ja mitään radikaaleja muutoksia ei tule. Tarkkaavaisesti opetusta seuraava saattaa kuitenkin huomata joitain yksittäisiä eroja aiempaan opetukseen. Merkittävin muutos näkyy harjoitusten kaavassa siten, että tekniikka- ja randori-harjoittelua ei ole erotettu toisistaan. Aiemmin harjoituksissa on usein ollut lämmittely, tekniikka-osio ja randorit lopussa. Nyt harjoitusten kaava tulee olemaan: lämmittely, yhdistetty tekniikka- ja randori-osio sekä loppuverryttely.

Tutkimuksessa noudatetaan tiukasti tutkimuseettisiä periaatteita, joihin lukeutuu mm. jokaisen osallistujan tietoturva. Osallistujista kerätään tutkimuksen aikana perustiedot, joihin lukeutuvat mm. ikä, sukupuoli, harrastusvuodet sekä vyön väri. Henkilötietoja säilytetään tietoturvalain edellyttämällä tavalla. Lisätietoa saatte tietosuojalomakkeesta.

Toivottavasti osallistutte tutkimukseen. Jos heräsi mitään kysyttävää, ottakaa rohkeasti yhteyttä!

Kunniottavasti,
Lauri Särkilahti
[redacted]

Appendix 3. Data protection announcement

Data protection announcement for participants regarding the Study

21.8.2019

Taking part in the study is voluntary and participants don't have to provide any information. Participation can be canceled at any time.

1. Study's name, nature and duration

A training program for judo according to nonlinear pedagogy

The study takes 11 weeks, starting on 2.9.2019

The thesis based on this study will be completed in spring 2020 at the latest.

2. What is the data processing based on

Eu general data protection regulation, article 6

☐ **Participant's consent**

3. People responsible for the study

Author of the study:

Lauri Särkilahti
[redacted]

Research supervisor:

Arja Sääkslahti
arja.saakslahti@jyu.fi
+358408053974

4. Purpose of the study

The purpose of this study is to create a training program for judo, following the contemporary view on skill acquisition. The theoretical framework for this program will be nonlinear pedagogy.

The study will be carried out in the adults' group of the judo section of Espoon urheilijat ry during the fall 2019. The participants are those judokas from said group who have given their consent to participate.

Participants' information I handled during the study. That information is gathered from the judo club's membership register and by a short basic information questionnaire. Participant information is pseudonymized and individuals cannot be identified by the thesis.

5. The study in practice

The study consists of the execution of a pre-planned training program. The program is carried out during the judo club's trainings and doesn't require any additional effort by the participants. The trainings are carried out, according to the club's timetable, on Mondays and Thursdays at 19.30-21.00. There will be 20 trainings in total. During the study there will be a one-week break if the club decides so.

During the trainings, participants may be asked for their opinion on the trainings or to answer a short questionnaire regarding the contents of the trainings.

6. Possible benefits and disadvantages for participants

Participants get to take part in trainings whose program is strongly based on the current scientific evidence on effective skill acquisition. It will offer variation as well as new ideas for experienced practitioners and a good start for beginners.

There won't be other disadvantages to participants than the inherent risk of injury, that exists in all judo trainings

7. Protection of personal data

The data gathered in the study is handled confidentially according to data protection legislation. Your information cannot be identified in any results, reports or publications.

Personal information is pseudonymized and stored in a locked space. When they are handled, they are under constants surveillance by the author of the study.

In results, you are only referred to using an unidentifiable code.

The research data is stored according to the data protection practices of Jyväskylä University.

8. Research results

A thesis will be written based on this study

9. Rights of the participants

Participants have the right to cancel their consent. If they cancel, their data will not be used in the study.

Participants have the right to file a complaint to the Office of the data protection ombudsman if they feel that the current legislation has been violated regarding the handling of their personal information (read more: http://www.tietosuoja.fi).

10. Storage of personal information

The data registry will be stored pseudonymized according to data protection guidelines until the study is concluded. Then the data will be disposed of.

11. Implementation of the participants' rights

If you have any questions regarding the participants' rights, you can contact the author of the study

Appendix 4. Tietosuojailmoitus

TIETOSUOJAILMOITUS TUTKIMUKSESTA TUTKIMUKSEEN OSALLISTUVALLE

21.8.2019

Tutkimukseen osallistuminen on vapaaehtoista, eikä tutkittavan ole pakko toimittaa mitään tietoja, tutkimukseen osallistumisen voi keskeyttää.

1. Tutkimuksen nimi, LUONNE JA kesto

Nonlineaarisen pedagogiikan mukainen harjoitusohjelma judoon

Tutkimus kestää 11 viikkoa, alkaen 2.9.2019

Tutkimuksen perusteella tehtävä opinnäytetyö valmistuu viimeistään keväällä 2020

2. Mihin henkilötietojen käsittely perustuu

EU:n yleinen tietosuoja-asetus, artikla 6, kohta 1

☐ **Tutkittavan suostumus**

3. Tutkimuksesta vastaavat tahot

Tutkimuksen tekijä:

Lauri Särkilahti
[redacted]

Tutkimuksen ohjaaja:

Arja Sääkslahti
arja.saakslahti@jyu.fi
+358408053974

4. Tutkimuksen tausta ja tarkoitus

Tämän tutkimuksen tavoitteena on luoda nykyaikaisen taidon oppimiskäsityksen mukainen harjoitusohjelma judon opettamiseen. Teoreettisena viitekehyksenä harjoitusohjelmalle käytetään nonlineaarista pedagogiikkaa.

Tutkimus toteutetaan Espoon Urheilijoiden judojaoston aikuisten harjoitusryhmässä syksyllä 2019. Tutkimukseen osallistuu aikuisten ryhmästä ne henkilöt, jotka ovat antaneet suostumuksensa osallistumiselle.

Tutkimuksessa käsitellään henkilötietoa, jotka saadaan seuran jäsenrekisteristä sekä lyhyellä perustietokyselyllä. Osallistujien tiedot pseudonymisoidaan ja henkilöt eivät ole tunnistettavissa tutkimusraportista.

5. Tutkimuksen toteuttaminen käytännössä

Tutkimus koostuu suunnitellun harjoitusohjelman toteuttamisesta harjoitusten yhteydessä, eikä vaadi tutkittavalta mitään ylimääräistä vaivaa. Harjoitukset toteutetaan seuran harjoitusaikataulun mukaisesti maanantaisin ja torstaisin 19.30-21.00. Harjoituskertoja on yhteensä 20, jolloin koko kesto on 10 viikkoa. Syysloman aikana pidetään viikon tauko, jos seuran toimesta näin päätetään.

Harjoitusten yhteydessä osallistujilta saatetaan kysyä mielipiteitä harjoituksista tai pyytää vastaamaan lyhyeeseen kyselyyn liittyen harjoitusten sisältöihin.

6. Tutkimuksen mahdolliset hyödyt ja haitat tutkittaville

Tutkittavat pääsevät osallistumaan harjoituksiin, joiden ohjelma perustuu vahvasti tämän hetkiselle tieteelliselle näytölle tehokkaasta taidon oppimisesta. Se tarjoaa vaihtelua ja uusia ideoita lajia jo pidempään harrastaneille sekä hyvän aloituksen lajia vasta aloitteleville.

Osallistujille ei aiheudu tutkimuksesta muita haittoja, kuin kaikkiin judoharjoituksiin sisältyvä loukkaantumisriski.

7. Henkilötietojen suojaaminen

Tutkimuksessa kerättyjä tietoja ja tutkimustuloksia käsitellään luottamuksellisesti tietosuojalainsäädännön edellyttämällä tavalla. Tietojasi ei voida tunnistaa tutkimukseen liittyvistä tutkimustuloksista, selvityksistä tai julkaisuista.

Henkilötiedot pseudonymisoidaan ja säilytetään lukitussa tilassa. Kun niitä käsitellään, ovat ne tutkijan jatkuvassa valvonnassa.

Tutkimustuloksissa ja muissa asiakirjoissa sinuun viitataan vain tunnistekoodilla.

Tutkimusaineistoa säilytetään Jyväskylän yliopisto tutkimusaineiston käsittelyä koskevien tietoturvakäytänteiden mukaisesti.

8. Tutkimustulokset

Tutkimuksesta valmistuu opinnäytetyö.

9. Tutkittavan oikeudet ja niistä poikkeaminen

Tutkittavalla on oikeus peruuttaa antamansa suostumus, kun henkilötietojen käsittely perustuu suostumukseen. Jos tutkittava peruuttaa suostumuksensa, hänen tietojaan ei käytetä enää tutkimuksessa.

Tutkittavalla on oikeus tehdä valitus Tietosuojavaltuutetun toimistoon, mikäli tutkittava katsoo, että häntä koskevien henkilötietojen käsittelyssä on rikottu voimassa olevaa tietosuojalainsäädäntöä. (lue lisää: http://www.tietosuoja.fi).

Tutkimuksessa ei poiketa muista tietosuojalainsäädännön mukaisista tutkittavan oikeuksista.

10. Henkilötietojen säilyttäminen ja arkistointi

Rekisteriä säilytetään pseudonymisoituna tietosuoja-asetusten mukaisesti kunnes tutkimus on päättynyt, minkä jälkeen aineisto hävitetään.

11. Rekisteröidyn oikeuksien toteuttaminen

Jos sinulla on kysyttävää rekisteröidyn oikeuksista voit olla yhteydessä tutkimuksen tekijään.

Appendix 5. Consent form

Jyväskylä University

Consent to a scientific study

I have been asked to participate in the study: A TRAINING PROGRAM FOR JUDO ACCORDING TO NONLINEAR PEDAGOGY.

I have read and understood the handout regarding the study and have gotten enough information about its execution. All my questions regarding it have been answered. I have had enough time to consider whether to participate.

I understand that participating is voluntary. I have the right to cancel and discontinue my participation at any point without having to give a reason. Discontinuing or canceling my participation don't cause any negative consequences for me.

I won't participate in the trainings when I have the flu or fever, when I'm still recovering from an illness or an injury or when I'm otherwise not feeling well.

I have read and understood the data protection announcement's information on my rights and limitations as a registered participant.

By signing this consent form, I accept the use of my information according to the data protection announcement.

☐ YES

With my signature, I confirm that I will participate in the study and will voluntary subject myself to being studied. I also agree to follow the rules and instructions mentioned above

_____ _____

Signature *Date*

_____ _____

Name *Birth date*

_____ _____

Years training judo *Belt color*

Suostumus vastaanotettu

_____ _____

Recipient's signature *Date*

_____

Name

The original, signed document is left with the responsible director of the study and a copy will be given to the participant. The consent will be stored securely as long as it isn't anonybmized. If it gets anonymized or disposed of, it isn't necessary to keep this consent form anymore.

Appendix 6. Suostumuslomake

Jyväskylän yliopisto

SUOSTUMUS TIETEELLISEEN TUTKIMUKSEEN

Minua on pyydetty osallistumaan tutkimukseen: NONLINEAARISEN PEDAGOGIIKAN MUKAINEN HARJOITUSOHJELMA JUDOON.

Olen perehtynyt tutkimusta koskevaan tiedotteeseen ja saanut riittävästi tietoa tutkimuksesta ja sen toteuttamisesta ja olen saanut riittävän vastauksen kaikkiin tutkimusta koskeviin kysymyksiini. Selvitykset antoi Lauri Särkilahti. Minulla on ollut riittävästi aikaa harkita tutkimukseen osallistumista.

Ymmärrän, että tähän tutkimukseen osallistuminen on vapaaehtoista. Minulla on oikeus, milloin tahansa tutkimuksen aikana ja syytä ilmoittamatta keskeyttää tutkimukseen osallistuminen tai peruuttaa suostumukseni tutkimukseen. Tutkimuksen keskeyttämisestä tai suostumuksen peruuttamisesta ei aiheudu minulle kielteisiä seuraamuksia.

En osallistu mittauksiin flunssaisena, kuumeisena, toipilaana tai muuten huonovointisena.

Olen tutustunut tietosuojailmoituksessa kerrottuihin rekisteröidyn oikeusiin ja rajoituksiin.

Allekirjoittamalla suostumuslomakkeen hyväksyn tietojeni käytön tietosuojailmoituksessa kuvattuun tutkimukseen.

☐ Kyllä

Allekirjoituksellani vahvistan, että osallistun tutkimukseen ja suostun vapaaehtoisesti tutkittavaksi sekä annan luvan edellä kerrottuihin asioihin.

_____ _____

Allekirjoitus *Päiväys*

_____ _____

Nimen selvennys *Syntymäaika*

_____ _____

Judon harrastusvuodet *Vyön väri*

Suostumus vastaanotettu

_____ _____

Vastaanottajan allekirjoitus *Päiväys*

_____

Nimen selvennys

Alkuperäinen allekirjoitettu asiakirja jää tutkimuksen vastuullisen johtajan arkistoon ja kopio annetaan tutkittavalle. Suostumusta säilytetään tietoturvallisesti niin kauan kuin aineisto on tunnisteellisessa muodossa. Jos aineisto anonymisoidaan tai hävitetään suostumusta ei tarvitse enää säilyttää.

Appendix 7. Training program outline

Training session	Session topic	Notes on the session
1	Elements of judo: Posture, movement & grips	
2	Elements of a judo match: Attacking #1	When and how to attack
3	Elements of a judo match: Attacking #2	Opportunities for throwing
4	Elements of a judo match: Attacking #3	Pushing & pulling to create a reaction
5	Attacking in ne-waza	
6	Basic structure of a judo match	
7	Throwing techniques: Lever throws	
8	Throwing techniques: Throws of a couple of forces	
9	Specific positions in ne waza: Half-guard and pins	
10	Specific position in ne waza: closed guard	Understanding the position and tasks in it
11	Specific position in ne-waza: Back mount	Understanding the position and tasks in it
12	Specific throw: Uki goshi & koshi guruma	
13	Specific throw: Uchi mata	Simple step-over counter to uchi mata as well
14	Countering uchi mata: Kosoto gake & Ura nage	
15	Yoko-shiho gatame & escape from it	
16	Holding and escaping pins	
17	Specific techniques in ne waza: juji gatame	Basics of attacking and defending
18	Finishing with juji gatame	
19	Fight strategy	Basics of fight strategy
20	Creating an individaul fight strategy	

Appendix 8. Lession plan template

LESSION PLAN:					
Coach: Lauri Särkilahti				**Date:**	
				Time: 19:30-21:00	
Learning outcomes:				**Group:** Espoon urheilijat	
Beginner:				**Notes:**	
Intermediate:					
Advanced:					

TEACHING FOCUS	LEARNING TASKS	CONSTRAINT MANIPULATION	INFORMATION	TIME	FEATURES OF A NONLINEAR PEDAGOGY

Appendix 9. NLP session reflection tool

x.x.2019 Session x -

Pre-lesson	**Learning outcomes**		**Score** - / x	**Feedback/ Reflection**
	Session goals are based on *individual needs* of all via identification of key rate limiters (3 levels: beginner, intermediate, advanced)			
	Learning outcomes to be achieved by the end of the session. The performes should be able to:	1.		
		2.		
		3.		
	Learning task design	*Simulates* the performance environment through *task simplification*		
	Are learning tasks designed to create improvement?	Learning tasks *match needs* of the performer given the current *status of the individual(s)*		
		Observation and identification of barriers to performance goals (current *rate limiters)*		
		Guides discovery via *implicit learning*		
		Allows *exploration* to promote problem solving		
In-lesson	**Adaptation of task based on emergent behaviors during lesson**	Learning tasks match needs of the performer given the current status of the individual		
		Some parts of the session take students out of their comfort zone *(creating metastability)*		
		Promotes *adaptability* in performance		
		Session is *adapted on-line* based on *emergent* performance		
		Measurable and based on factual outcome goals		
	Task engagement	Creates complete *immersion* in the task		
	Objective and diagnostic information about performance	Implicit and instant		
		Attuned to individual's emotions and thoughts		
		Time-outs develop awareness through reflective questioning		
	Guided refelection	The athlete's mind is immersed in examining the session through a process of questioning		

		Provides information about what is required to get better		
		Student's directed to what is required to move to the next level of performance		
		Student's propose what adjustments to constraints are needed for success in achieving the goal		
Post-lesson	**Critical analysis**	Students reflect on achievement of goal - success / non-success		
		Students evaluate own level of performance and the difference between themselves and the next/elite level		
		Students propose what constraints should be manipulated to improve performance of self/team next lesson		