HIERARCHICAL CLASSIFICATION OF EXPERT MODELS OF EXERCISES DESIGNED TO ELIMINATE SPECIFIC MISTAKES OCCURRING IN SHORT SKI TURN

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ABSTRACT

The aim of the present study was to examine the structure of an expert model of exercises designed to eliminate the *Lack of specific ski movement* mistake in short ski turn, as well as offer a hierarchical classification of the expert model. For this purpose, a two-stage research was conducted. During the first stage of the research the exercises with the purpose of *Lack of specific ski movement* mistake elimination were designed by 20 skiing experts aged 25 to 45. By means of email and coordinated by the paper author, the experts first designed a model of 14 methodical exercises and subsequently selected the five most relevant ones, ranking them on a scale from 1 to 5. A nonparametric chi - square test (χ^2) was used. The research showed there was no significant variation across the experts' evaluation of the five most important methodical exercises (χ^2 = 21,69; p = 0,06). The expert model of the most important methodical exercises for the *Lack of specific ski movement* mistake correction thus includes the following: *Holding a ski stick under the handle, Jump turns, Hands on hips, Unbuttoned ski boots and Ski poles in vertical position in forwards*. 307 skiing professionals of various levels of expertise participated in the second stage of the research, whose aim was to classify the *Lack of specific ski movement* mistake elimination exercises. The participants' task was to rank the exercises based on their relevance. Total amounts of rank sums (ΣR) were calculated, the Kruskal-Wallis test (H-test) was carried out, and the corresponding levels of significance (p) were recorded, for the purpose of comparing the significance of diversity between rank sums and the expert model. The statistically significant difference was found between the rank sums (ΣR) of the most efficient exercises for the *Lack of specific ski movement* mistake correction (H = 198,19; p < 0,001). The results obtained in the two stages of the research provide valuable insights regarding the methods of short ski turns. The hierarchical classification of the most important methodical corrective exercises obtained from ski teachers and professionals with different levels of education and expertise yields accurate and precise data about corrective methodical exercises in the process of studying short ski turn. Any further research regarding the same object should evaluate the designed expert model of the most important methodical exercises, as well as their hierarchical classification, across different groups of participants.

Keywords: Expert evaluation; alpine skiing; methodical exercises; short ski turns

Introduction

The successful performance in alpine skiing depends on the quality and the nature of the skiing equipment used, but mostly on the level of skiing education, experience and way of teaching employed by skiing experts. The skiing skill acquisition can be defined as the process of systematic adoption and perfection of specific structure of dynamic movement, with the aim of efficient performance in various conditions and types of ski slopes. Ski school programmes are especially significant in the process of alpine skiers' instruction and training. The principle of progression in ski schools means that learners shift from easy activities designed to guarantee safety and progression towards the more advanced skills, for example, from the snow plough to the parallel ski. The skiing school programme models enable and accelerate the process of skiing skill acquisition (Jurković & Jurković, 2005; Matković et al. 2004; Lešnik & Žvan 2010). The basis of the programme facilitates the adoption of various techniques of alpine skiing and secures the gradual progress of skiing skill acquisition. All the mentioned factors are the result of specific divisions and formations of different skiing school programme models (Feinberg-Densmore, 2000; John, 2006; Murovec, 2006; Anderson, 2007; Puškarić, 2010; Božidar et al. 2010). In relation to the mentioned and with the aim of rational performance and lower energy consumption, the skiing elements and methodological exercises should follow one another in a logical methodological order (Franjko, 2007; Kuna et al. 2013). Furthermore, when coordinating actions, good skiers use optimal amount of energy for transit across a slope compared to those with lower levels of skiing expertise (Bucher et al. 2014; Maleš et al. 2013). Moreover, good skiers require less energy in order to perform any of these elements than the skiers of lower skiing proficiency level. Skiing technique changes also depend on the skier's fitness level, such as the ability to produce power by the upper and lower limbs, equipment and snow quality, height and weight, as well as tactical aspects and individual preferences based on earlier experience (Hausken, 2017.)

The key factor in the process of skiing skill acquisition and advancement is professional and high-quality guidance provided by ski experts, teachers and instructors. To be able to provide adequate instruction, a skiing teacher or trainer should be highly knowledgeable in skiing theory and practice. Not only that, but he/she should also understand the methodological and didactic principles of training process as well as the basics of psychology. We must accept the fact that potential students differ substantially regarding the level and the degree of anthropological abilities and personal traits (Emeterio & González-Badillo 2010; Malliou et al. 2004). To be able to plan and execute an adequate training process ski instructors should acknowledge the athletes' diverse maturity levels and growth rates, especially so as to prevent late maturing athletes from sustaining injuries (Müller, Hildebrandt, Müller, Fink et al., 2017). Therefore, it is essential that skiing teachers and instructors understand the dynamics of motor skills acquisition process and other concepts pertaining to motor development. Without these preconditions, skiing instructors will not apply an adequate teaching method, which may decelerate the learners' progress or even be dangerous.

All this applies to short ski turn acquisition, which is taught in Croatian advanced skiing school programme. Short ski turn is a dynamic technical element, which primarily consists of pronounced creasing and stretching of the body with minimal rotation of the trunk, and almost constant skiing on the edges of the skies. The second important matter is constant control of speed, which is done by dynamic and rhythmic turn shifting, from the right side to the left side. Constant shifting between sides is enabled by means of lateral deflections of the body. Indeed, turning produces centrifugal force, which leads to an increased effective weight of the skier and hence higher normal reaction and friction forces compared to the case of fall-line gliding. As the centrifugal force depends on the speed and local radius of the skier's trajectory, it varies during the run and its overall effect cannot be estimated easily (Komissarov, 2018.). Short ski turns are an exception in that case because every turn is approximately equal, so the skier can efficiently control the speed. The pressure translocation from the forefoot (at the beginning of the turn) towards the heel (at the end of the turn) is still a feature of short ski turn (Falda-Buscaiot et al. 2017). The variables of the ideal-carving equation are the velocity of the skier, the angle between the trajectory of the skier and the horizontal, and the instantaneous curvature radius of the skier's trajectory (Jentschura & O`Fahrbach, 2003.).

Previous research on the matter (Kuna, 2013) has defined the expert model for teaching dynamic short ski turns, the typical mistakes occurring in the process, and the most important exercises used for their elimination. Research on the matter is aimed at a detailed elaboration of methodical approach to short ski turn instruction to improve the quality of the acquisition process.

Since one of the typical mistakes in short ski turns is *Lack of specific ski movement,* this research had two objectives: a) To form an expert model of the most important corrective methodical exercises used for the elimination of the *Lack of specific ski movement* mistake, manifested through the execution of short ski turn, b) To form a hierarchical classification of expert models of most important exercises for elimination of the *Lack of specific ski movement* mistake through execution of short ski turn.

Methods

- *Participants and procedure*

Data was collected in order to form an expert model of the most important corrective exercises used for *Lack of specific ski movement* mistake elimination; a mistake that most often occurs during the execution of short ski turn. The sample comprised of twenty state ski demonstrators. There were eight ski demonstrators from Croatian team, six ski demonstrators from Slovenian team and six from Bosnia and Herzegovina team. Following the request of the research authors, and with the approval of the president and the members of the executive council of HZUTS Croatia, ZUTS Slovenia and ATUS Bosnia and Herzegovina, the state ski demonstrators agreed to take part in designing the expert model for elimination of the *Lack of specific ski movement* mistake; a mistake that occurs during the execution of short ski turn. Participation requests were sent to the participants via email, along with the descriptions of each of the elements and their role in the research. The experts devised a model of the most important corrective methodical exercises for the *Lack of specific ski movement* mistake elimination. They had to choose between fourteen corrective exercises which are: *Short turn to one side - STOS, From snowplough turn cross to the short ski turn - FSTCST, From parallel ski turn cross to the short ski turn - FPSTCST, Short ski turn in sideling direction - STISD, Hands on hips - HOH, Ski poles behind in the back - SPBIB, Ski poles in vertical position with arms forward - SPIVPAF, Hands on the thighs - HOT, Switching the ski poles around the body - STSAB, Ski poles in parallel position with arms in forwards - SPPAF, Unbuttoned ski boots - USB, Jump turns - JT, Sting both ski poles under the outside ski - SBSPUOS, Holding a ski poles under the hands- HSPUH.*

Once the expert model was defined, the participants were asked to select/highlight the five most important corrective exercises. In order to make the process more transparent and allow the participants to distinguish between different elements, all exercises were filmed and converted into GIF format. Next, an online poll was created and sent to all participants from the second stage of the research. The sample comprised of four hundred and sixty ski teachers with various levels of expertise from Croatia, Slovenia and Bosnia and Herzegovina. They were required to take the poll, answering all the questions, as well as send their personal data and IP addresses. Having been carefully examined, three hundred and seven results were used in further data analysis. Thus, the final sample of participants consisted of one hundred and eighteen Croatian, one hundred and nine Slovenian and sixty Bosnian ski teachers, aged twenty-five to forty-five.

- *Sample of variables and statistical analysis*

A sample of variables was defined in the first stage of the research, with the expert model of most important corrective exercises used for the *Lack of specific ski movement* mistake elimination consisting of: *Holding a ski stick under the handle, Jump turns, Hands on hips, Unbuttoned ski boots and Ski poles in vertical position in forwards*.

The participants' task was to rank the exercises based on their relevance. The significance level was set to $p < 0{,}001$. Total amounts of rank sums were calculated, the Kruskal-Wallis test (H-test) was performed, and the corresponding levels of significance were recorded with the purpose of comparing the significance of diversity between rank sums and the expert model**.** Experts first designed a model of 14 methodical exercises and subsequently selected the five most relevant

ones, ranking them on a scale from 1 to 5. For the purpose of it nonparametric chi - square test (χ^2) was used. Data analysis was completed with the help of "Statistica Windows 12.0" program.

Results and Discussion

Table 1 shows total values of the most important corrective methodical exercises ranking. Based on the results, it can be said that although there is no statistically significant difference, the numbers come very close to statistical significance, in the evaluation of five most important corrective methodical exercises for the *Lack of specific ski movement* mistake elimination among the choices made by experts. The reason for this might be the fact that the experts defined too wide a spectrum of methodical exercises which have specific values and contributions to the *Lack of specific ski movement* mistake elimination, so the distribution of their values was dispersed. Nevertheless, according to the results gained from the experts' evaluation of five most important corrective exercises, certain corrective exercises are of higher frequencies. In other words, they were selected more often by the experts than other exercises. And the main reason for this is their collective contribution to the elimination of the *Lack of specific ski movement*; a mistake typically occurring during the execution of short ski turn.

Table 1 *Expert evaluation of the most important corrective exercises used for the elimination of the* ***Lack of specific ski movement*** *mistake occurring during the execution of the short ski turn. Observed (OF) and expected (EF) frequencies of expert evaluation for corrective exercises, value of Chi-square test (χ2) and level of significance (p)*

The most important corrective exercises for the *Lack of specific ski movement* mistake elimination	**OF**	**EF**
STOS	3	4,28
FSTCST	3	4,28
FPSTCST	3	4,28
STISD	2	4,28
HOH	8	4,28
SPBIB	1	4,28
SPIVPAF	8	4,28
HOT	4	4,28
STSAB	4	4,28
SPPAF	1	4,28
USB	6	4,28
JT	9	4,28
SBSPUOS	2	4,28
HSPUH	6	4,28
	$\chi^2 = 21,69$ **p = 0,06**	

By analysing the five most important corrective methodical exercises for the *Lack of specific ski movement* mistake elimination, it becomes clear that the exercise with the highest value is *Jump turns.* The goal of the exercise is to jump from one side to the other, which requires the skier to perform an accentuated vertical motion with a squat. This action can reflect the skier's jump and movement at the same time and set the skis in the direction of the new turn.

The second most relevant exercise according to the expert evaluation of the most important corrective exercises for the *Lack of specific ski movement* mistake elimination is the exercise called *Ski poles in vertical position with arms in forwards* and *Hands on hips*.

During the execution of short ski turns with the help of the *Ski poles in vertical position with arms in forwards* exercise, the skier should be focused on rhythmic and proper timing of ski movement,

especially when it comes to vertical and circular moves, as well as maintain the correct gravity centre. These are the main elements that determine the rhythm and the direction of the skier's course. To perform short ski turns in succession, a skier needs to hold his ski sticks vertically in front of him and establish a controlled upright position of the upper body while constantly controlling the speed and the direction. These are the preconditions for the execution of specific ski movements. During the execution of short ski turns with the help of the *Hands on hips* exercise, the skier again has to establish and maintain the correct centre of gravity, and have absolute control of the direction which determines the execution of specific vertical, lateral and circular ski movements.

All the points presented above account for the expert evaluation of those exercises in greater frequencies when it comes to the elimination of the *Lack of specific ski movement* mistake occurring during the execution of short ski turns.

In the third position of expert evaluation of the most important corrective exercises for the *Lack of specific ski movement* mistake elimination is the exercise called *Unbuttoned ski boots* and *Holding a ski poles under the handle.*

During the execution of short ski turn with unbuttoned ski boots, the skier needs to perform a specific ski movement because unbuttoned ski boots do not allow the same movement as skiing with buttoned ski boots. Accordingly, for the skier to move in desired direction and speed, he needs to perform specific short ski turns, otherwise the technique will be incorrect, and the desired direction and speed will not be achieved.

During the execution of short ski turn while holding ski sticks below the holding grip, the skier lowers his centre of gravity, which means that he should perform vertical movements in short ski turns, but also circular and other specific ski movements.

Table 2 *Rank sum of the evaluation of the most efficient corrective methodical exercises for the elimination of the* ***Lack of specific ski movement*** *mistake made during the execution of short ski turn, Kruskal-Wallis test (H-test) and level of significance (p)*

The most efficient corrective exercises for the *Lack of specific ski movement* mistake elimination					
	USB	**SPIVPAF**	**HOH**	**JT**	**ΣR**
USB					628
SPIVPAF	0,00				774
HOH	0,00	1,00			755
JT	0,00	0,00	0,00		1055
HSPUH	1,00	0,00	0,00	0,00	628
H = 198,19**; p** < 0,001					

The analysis of rank sum values for most efficient corrective methodical exercises, obtained from ski teachers with different levels of education (N=307), applying the H-test and p values, shows that there are statistically significant differences (Table 2).

By means of non-parametric post-hoc analysis, it has been found that there is significant difference (p = 0,000) between rank sums of the following methodical corrective exercises: *Unbuttoned ski boots, Ski poles in vertical position with arms in forwards, Hands on hips* and *Holding a ski poles under the handle.* Also, there is statistically significant difference (p = 0,000) between the variables: *Ski poles in vertical position with arms in forwards*, *Jump turns* and *Holding a ski poles under the handle*, as well as between variables: *Hands on hips*, *Jump turns* and *Holding a ski poles under the handle* and between *Jump turns* and *Holding a ski poles under the handle.*

According to the differences between rank sums of corrective methodical exercises as assessed by ski teachers of different levels of education, a hierarchical classification of selected exercises was formed. The corrective methodical exercise with the highest value in efficiency pertaining to the *Lack*

of specific ski movement mistake elimination is the *Jump turn.* The assessment carried out by ski teachers with different levels of education confirmed the relevance of this exercise as assessed by the experts. The reason for this are the accentuated vertical movements that are required in performance of the exercise *From one side to the other short ski turns. Holding ski poles under the handle* and *Unbuttoned ski boots* are the exercises ranked as second in relevance. The third place belongs to *Ski poles in vertical position with arms in forwards* and *Hands on hips* exercises.

The hierarchical classification of expert models of exercises used for the elimination of typical mistakes made during the execution of short ski turn shows that the exercises of the highest rank are the ones that involve vertical and circular movements, dominant in short ski turn performance. The exercises that involve an upright position of the upper body are of the lowest rank. These exercises are performed without ski sticks because the skiers are required to focus primarily on body movements and skiing rhythm. What needs to be pointed out is the lack of circular and vertical movement, very common among skiers, especially the unexperienced ones. Many skiers do not understand or do not practice the difference between short ski turns, dynamic parallel turns and carving turns, which needs to be improved. In comparison to other sports, very little research has been conducted for the skiing instruction methods. Most researches in alpine skiing are based on the expertise of skiers racing performance (Decroix et al 2017; Černohorski & Pustovrh, 2008). A better understanding of the differences across certain skiing techniques would allow the skiers to gain more experience on ski tracks and reduce their chances of getting injured. The implication for training instructors is that the skills of adapting these five methodical corrective exercises for the elimination of typical mistakes made during the execution of short ski turn aspects to meet individual needs every skier and should also be given due consideration alongside the technical skiing skills.

Conclusion

The results obtained by the research provide a very accurate and valuable insight regarding the most efficient corrective exercises for the elimination of the *Insufficient ski movement* mistake manifested through the execution of short ski turn. In addition to that, we presented the results of the efficiency of expert model of certain corrective exercises in skiing instruction. The hierarchical classification of expert model of most important corrective exercises for the mentioned mistake elimination will help teachers and instructors in the training processes planning and programming. Due to the thriving numbers of recreational and competitive skiers, there is a growing need for precise definition of appropriate exercises to employ in skiing instruction and training to make it as efficient as possible.

We need to consider the fact that most skiers have limited time to spend in instruction, mostly because of the costs included as well as their own everyday activities that prevent them from doing so. These circumstances bring about new challenges for us; namely the need to optimize the skiing instruction and the process of skiing skill acquisition. The beginners often stay on elementary level, because they perceive the advanced techniques as too complicated. The answer to this problem might be to conduct more research on the matter and consider the implications for practice change. This research represents only a part in a sequence of scientific papers with the purpose of forming a hierarchical classification of expert models of most important corrective exercises manifested in all skiing techniques. This fact will determine the direction of our future research as well, to finally arrive at the optimal hierarchical classification which would then be an undeniable methodical foundation for skiing instruction employed across the world.

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