



Training quality - what is it and how can we improve it?

Journal:	<i>International Journal of Sports Physiology and Performance</i>
Manuscript ID	IJSPP.2022-0484.R1
Manuscript Type:	Invited Commentary
Date Submitted by the Author:	02-Feb-2023
Complete List of Authors:	Bucher Sandbakk, Silvana; Norwegian University of Science and Technology, K.G.Jebsen – Centre of Exercise in Medicine Walther, Jacob; Norwegian University of Science and Technology, Centre for Elite Sports Research, Department of Neuromedicine and Movement Science Solli, Guro; Nord University, Department of Sports Science and Physical Education; NTNU, Centre for Elite Sports Research, Department of Neuromedicine and Movement Science, Norwegian University of Science and Technology Tønnessen, Espen; Kristiania University College, School of Health Sciences Haugen, Thomas; Kristiania University College, School of Health Sciences;
Keywords:	performance development, training organization, coaching, sport science

SCHOLARONE™
Manuscripts

1 **Training quality - what is it and how can we improve it?**

2

3 **Abstract**

4 **Purpose:** The concept of training quality reflects that the effect of training is dependent on
5 more than the mere product of training load (e.g., duration, intensity, frequency). The aims of
6 this commentary are to 1) propose a practice-oriented framework to describe training quality
7 and its general and context-dependent characteristics, and 2) discuss how athletes and coaches
8 can work to improve training quality.

9 **Conclusions:** Training quality can be viewed from different perspectives. The holistic
10 dimension includes the entire training process (goal setting, gap-analysis, application of training
11 principles and methods, etc.), while a narrower dimension encompasses the specific training
12 sessions and how they are executed in relation to the intended purpose. To capture the varying
13 contexts, we define training quality as the degree of excellence related to how the training
14 process or training sessions are executed to optimize adaptations and thereby improve overall
15 performance.

16 Although training quality is challenging to quantify, we argue that identification and assessment
17 of quality indicators will increase our scientific understanding and consequently help coaches
18 and athletes to improve training quality. We propose that the physical, technical, and
19 psychological factors of training quality can be improved through an individualized learning-
20 process of systematic planning, execution, and debriefing. However, assessment tools should
21 be identified and scientifically validated across different training sessions and **sports. We**
22 encourage further interventions to improve training quality.

23

24 **Keywords:** Performance development, training organization, coaching, sport science.

25 **Introduction**

26 Sports science has provided detailed quantitative information about *what* successful athletes
27 across multiple endurance sports do in their training to develop sport-specific physiological
28 capacities and performance.¹⁻⁴ Accordingly, our knowledge regarding the interplay of training
29 load factors such as duration, intensity, and frequency to stimulate the best possible adaptive
30 responses has improved **substantially**. However, when coaches and athletes describe key factors
31 leading to success, they often highlight *how* they work and *why* training practices are performed,
32 indicating that the quality of the training process and execution of training sessions are key
33 factors **separating the best from the rest**.³

34 In contrast to the large amount of research focusing on varying loading factors, the concept of
35 training quality including definition, underpinning factors, and strategies to improve training
36 quality, has been sparsely addressed. In their pioneering work three decades ago, Ericsson and
37 co-workers suggested that accumulated and domain-specific deliberate practice accounts for
38 the acquisition of expert performance in sports and comparable domains.⁵ However, their
39 approach is closely associated with training load, and a later meta-analysis demonstrated that
40 only 18% of the variation in sports performance was explained by accumulated deliberated
41 practice.⁶ This implies that complementary and multifaceted insights on the quality of the
42 training process and execution of training sessions are required.

43 The aims of this commentary are to 1) propose a practice-oriented framework to describe
44 training quality and its general and context-dependent characteristics, and 2) discuss how
45 athletes and coaches can work to improve training quality. Due to the limited scientific literature
46 within this topic, this commentary is mainly based on the present authors' interpretations of
47 best practice literature and personal communications with world-leading athletes and coaches
48 across multiple sports.

49

50 **What is training quality?**

51 Although widely used across different fields, it appears difficult to reach a unified, precise
52 definition of what quality is.⁷⁻⁹ Nevertheless, general distinctions can be observed between
53 *quality of a process* and *quality of results*, where the *quality of a process* includes how and why
54 planning, preparation and execution are performed to reach a specified overall goal. On the
55 other hand, *quality of a result* comprises the result of a process, typically operationalized by

56 objectively defined performance indicators in which high quality indicates a small deviation
57 from a gold standard.

58 In the training vernacular of athletes and coaches, training quality can reflect different
59 dimensions related to the long-term training process and how individual training sessions are
60 executed. Practitioners are typically concerned about the link between the executed session and
61 its intention, as illustrated by trail running GOAT Kilian Jornet: "...When I do every workout,
62 I'm thinking at why I'm doing this? What is the goal? A session is part of a plan to make
63 physiological, technical, muscular, metabolic, or mental adaptations, so I would focus on
64 different aspects during sessions to be sure I'm doing what I'm supposed to do. That means that
65 in some sessions I would be focusing on the speed, on others on the breathing, cardio or effort,
66 on others on the cadence, or in the feeling of regenerating, or in the technique. It is not just
67 about training hard but trying to focus on what really matters for that specific session...."¹⁰

68 This is in line with Shell et al.,¹¹ who defined training quality as an athlete's capacity to
69 complete a training session to the desired level. However, we argue that training quality has (at
70 least) two dimensions:

- 71 • The quality of the holistic training process (including goal setting, gap-analysis, application
72 of training principles and methods) expresses the degree to which the training process
73 facilitates long-term development of sport-specific requirements and the desired
74 performance level.
- 75 • The quality of the specific training session expresses the ability to optimize processes
76 influencing the execution of training in relation to the intended purpose of the specific
77 session.

78 These two dimensions of training quality are interconnected and complementary; the aim of the
79 training process is to facilitate well-balanced and periodized training load, including repeated
80 high-quality sessions. Subsequently, this provides stimulus for long-term adaptations and the
81 ability to maximize performance in competitions. The second dimension, focusing on the
82 executive quality of each session, is dependent upon a well-designed training process. In other
83 words, one dimension is either the input or the output of the other.

84 Overall, the mindsets, approaches to training, and views on training quality are shaped by the
85 varying actors' (i.e., athletes, coaches, and supporting staff) specified roles. Based on these
86 considerations, we argue that the meaning of training quality depends on the context. This is

87 likely part of the reason why no consensus around a clear definition of training quality has been
88 established. Therefore, to capture the varying contexts and dimensions, we hereby define
89 training quality as the degree of excellence related to how the training process or training
90 sessions are executed to optimize adaptations and/or improve overall performance. Hence, high
91 training quality over time will put the athletes in the best position to reach their competition
92 goals.

93

94 **Which factors influence training quality?**

95 The quality of the training process and training sessions is influenced by a myriad of factors,
96 including training load and restitution, skillset and experience of athlete and coach, training
97 peers, supporting staff, training environment and facilities, well-being, and life balance. High
98 training quality can only be achieved directly by the athlete via optimal preparation (sufficient
99 sleep, targeted nutrition, proper warm-up routines, etc.), execution (individualized workouts,
100 focus, intensity control, fine-tuning of skills in response to feedback etc.) and after sessions
101 (reflective exploration, post-workout routines, restitution actions, etc.). This requires a strong
102 sense of ownership of the training process, motivation, dedication, determination, and training
103 intelligence.¹²

104 An environment with high task-oriented learning motivation, high degree of participation and
105 fundamental safety and a good coach-athlete relationship is most likely a key to obtain high
106 training quality. Here, the coach will have a particular impact via actions directed towards the
107 athlete. Extensive sport-specific knowledge, experience, and pedagogic skills form basis for
108 effective goal-setting processes, development of training plans, organization of training and
109 optimal application of basic training principles. Via observations, measurements, and analyses
110 of the physiological, technical, tactical and psychological domains, and continuous
111 communication with the athlete, training plans and sessions can be fine-tuned and adjusted for
112 optimal adaptation.

113 Although a high-quality training process should facilitate that each session can be performed
114 according to its defined intention, athletes are human beings (not machines) influenced by many
115 factors. Accordingly, an additional skill is the coach's and athlete's ability to dynamically adjust
116 both training load and intention of single sessions due to changes in mental and/or physical
117 state. In this context, this athlete-coach interplay represents the "gold" and inner core of the
118 training process, differentiating good from extraordinary performance development. If training

119 quality was not an issue, the role of the coach would have been superfluous, and all athletes
120 could have followed a one-size-fits-all approach.

121

122 **Is it possible to assess training quality?**

123 Acknowledging the holistic and multifaceted nature of training quality, quantification is
124 challenging, and there is very limited empirical research that has attempted to measure it. Still,
125 we argue that identification and assessment of indicators of training quality are important for at
126 least two reasons: 1) to provide discussions around the impact of various factors, and 2) to build
127 a basis for coaches and athletes to further improve training quality.

128 Shell et al.¹¹ divided quality indicators within a training session into physical, technical, and
129 mental factors. According to the authors, understanding these respective categories must be
130 aligned with the session intention and goal(s). In addition, our view is that determination of
131 training quality must be specified according to sports, sessions, and individuals, either via
132 objective or subjective assessments. Quantitative measures of training quality include
133 quantifiable differences between intended and exerted effort (e.g., how heart rate, ratings of
134 perceived exertion, speed or power deviate from what was intended for the session), as well as
135 the use of questionnaires, planning tools, training diaries, etc.^{13, 14} Indeed, qualitative data are
136 more challenging to rely on due to their interpretive nature. Subjective perceptions of training
137 quality may be unpredictable and could be affected by a myriad of related and unrelated factors
138 to training quality itself.¹⁵

139 We argue that a combination of selected qualitative and quantitative indicators of training
140 quality should be assessed and deliberately implemented in training and coaching practice. The
141 selection of indicators must be based on a clear purpose related to the specific development
142 goals of the athlete. Furthermore, training quality measurements must be interpreted according
143 to the session's intention. **Within this context, experienced coaches and staff who have achieved
144 success with multiple athletes over time are likely best qualified to judge.**

145

146 **How can high training quality be developed?**

147 We argue that the quality of the entire training process as well as the quality of single training
148 sessions can be developed **and fine-tuned** over time through **optimal** interactions among the
149 athlete, coach and supporting staff. To maximize the probability for success, it is important that
150 athletes are affiliated with good coaches and that training quality is continuously subject to

151 improvement through a circular learning-process. The varying steps of the training process
152 (e.g., goal setting, identifying the gaps between current and desired state, and organization and
153 planning of training) repeat themselves, either at the macro-, meso- or micro-level, and learning
154 becomes facilitated through analyses and debriefings of the performed sessions. The coach
155 should have high knowledge and comprehensive overview of the holistic training process in
156 terms of long-term planning, competition activity and team management. However, the athlete
157 is key to high quality during single training sessions, demonstrated by their ability to execute
158 each session according to **reach the intended goal**.¹¹

159 Our experience from combined decades in elite sports is that the best practitioners have
160 established a culture of continuous learning and development through appropriate systems and
161 processes. **The best athletes are continuously searching for improvements, and the** best coaches
162 manage to challenge and guide their athletes in a way where training quality develops. Figure
163 1 exemplifies how we experience that world-leading athletes and coaches across various sports
164 work to increase the quality of training sessions for their athletes.

165 In addition, we suggest a process where the athlete and coach together define the intentions of
166 the key sessions as well as their most important quality-indicators. Thereafter, they together
167 define the required level to achieve high training quality for each of these indicators before they
168 individually rate the current state of the athlete. Finally, they use their judgement to **identify**
169 **strengths** and detect gaps between the current and required level leading to the development of
170 goals for further improvement of training quality. Although we argue that the described quality
171 dimensions can be improved through such an individualized learning-process, we emphasize
172 that neither the assessment tools nor the employment of such methods have been scientifically
173 validated.

174

175 *****Figure 1 about here*****

176

177 **Practical applications**

178 Successful athletes and coaches consider training quality highly important for performance
179 development in sports. In this commentary, an attempt has been made to address some
180 fundamental questions related to this topic: What is training quality? Which factors influence
181 training quality? Is it possible to assess training quality? How can high training quality be
182 developed? Although the content of this practical-oriented framework must be interpreted with

183 caution, we intend to provide a point of departure and encourage future studies to explore
184 training quality more in detail.

185

186 **Conclusions**

187 Training quality can be viewed from different perspectives. The holistic dimension includes the
188 entire training process, while a narrower and more reductionistic dimension encompasses the
189 specific training sessions and how they are executed in relation to the intended purpose. To
190 capture the varying contexts, we have defined training quality as the degree of excellence
191 related to how the training process or training sessions are executed to optimize adaptations
192 and/or improve overall performance. We argue that an environment with high task-oriented
193 learning motivation, continuous and dynamic athlete-coach interaction, and athlete ownership
194 and dedication in planning/preparation, execution and debriefing/evaluation are considered
195 particularly important to develop high training quality.

196

197 **References**

- 198 1. Haugen, T, O Sandbakk, S Seiler, and E Tonnessen, The Training Characteristics of
199 World-Class Distance Runners: An Integration of Scientific Literature and Results-
200 Proven Practice. *Sports Med Open*, 2022;8(1):46. doi:10.1186/s40798-022-00438-7
- 201 2. Haugen, T, O Sandbakk, E Enoksen, S Seiler, and E Tonnessen, Crossing the Golden
202 Training Divide: The Science and Practice of Training World-Class 800- and 1500-m
203 Runners. *Sports Med*, 2021;51(9):1835-1854. doi:10.1007/s40279-021-01481-2
- 204 3. Solli, GS, E Tonnessen, and O Sandbakk, The Training Characteristics of the World's
205 Most Successful Female Cross-Country Skier. *Front Physiol*, 2017;8(1069).
206 doi:10.3389/fphys.2017.01069
- 207 4. Tonnessen, E, O Sylta, TA Haugen, E Hem, IS Svendsen, and S Seiler, The road to
208 gold: training and peaking characteristics in the year prior to a gold medal endurance
209 performance. *PLoS One*, 2014;9(7):e101796. doi:10.1371/journal.pone.0101796
- 210 5. Ericsson, KA, RT Krampe, and C Tesch-Römer, The role of deliberate practice in the
211 acquisition of expert performance. *Psychological review*, 1993;100(3):363.
- 212 6. Macnamara, BN, D Moreau, and DZ Hambrick, The Relationship Between Deliberate
213 Practice and Performance in Sports: A Meta-Analysis. *Perspect Psychol Sci*,
214 2016;11(3):333-50. doi:10.1177/1745691616635591
- 215 7. Wittek, L and T Kvernbekk, On the problems of asking for a definition of quality in
216 education. *Scandinavian Journal of Educational Research*, 2011;55(6):671-684.
- 217 8. Westerheijden, DF, B Stensaker, and MJ Rosa, *Quality assurance in higher education:
218 Trends in regulation, translation and transformation*. Vol. 20. Springer Science &
219 Business Media; 2007.
- 220 9. Chapman, AD, *Principles of data quality*. GBIF; 2005.
- 221 10. Jorner, K. Training for long and short trail running. 2022 [cited 28.11.2022]. Available
222 from: <https://mtnath.com/training2022/>.

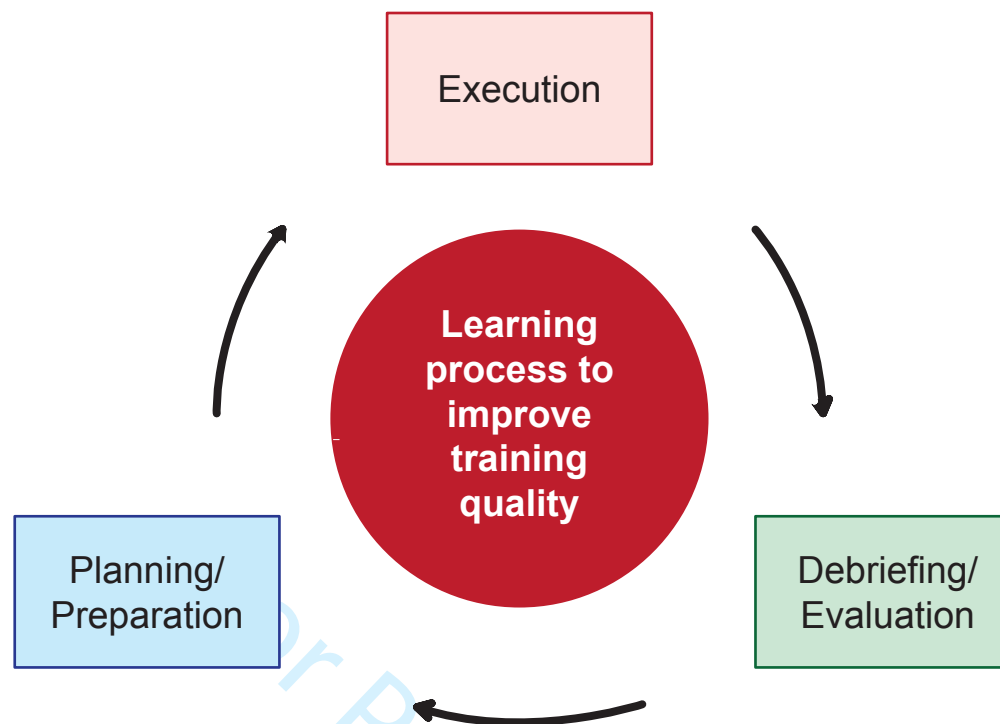
- 223 11. Shell, SJ, K Slattery, B Clark, JR Broatch, SL Halson, and AJ Coutts, Development and
224 validity of the subjective training quality scale. *Eur J Sport Sci*, 2022;1-8.
225 doi:10.1080/17461391.2022.2111276
- 226 12. Jordalen, G, P-N Lemyre, and N Durand-Bush, Interplay of motivation and self-
227 regulation throughout the development of elite athletes. *Qualitative Research in Sport,
228 Exercise and Health*, 2020;12(3):377-391.
- 229 13. Voet, JG, RP Lamberts, JJ de Koning, J de Jong, C Foster, and T van Erp, Differences
230 in execution and perception of training sessions as experienced by (semi-) professional
231 cyclists and their coach. *Eur J Sport Sci*, 2022;22(10):1586-1594.
232 doi:10.1080/17461391.2021.1979102
- 233 14. Inoue, A, P Dos Santos Bunn, EC do Carmo, E Lattari, and EB da Silva, Internal
234 Training Load Perceived by Athletes and Planned by Coaches: A Systematic Review
235 and Meta-Analysis. *Sports Med Open*, 2022;8(1):35. doi:10.1186/s40798-022-00420-3
- 236 15. Montull, L, A Slapsinskaite-Dackeviciene, J Kiely, R Hristovski, and N Balague,
237 Integrative Proposals of Sports Monitoring: Subjective Outperforms Objective
238 Monitoring. *Sports Med Open*, 2022;8(1):41. doi:10.1186/s40798-022-00432-z

239

240 **Figure legends**

241 Figure 1. Illustration of a circular learning process to promote continuous improvements in
242 training quality. Best-practice examples from world-leading endurance coaches and athletes are
243 provided for 1) planning and preparation procedures before a training session, 2) focus areas
244 during a session, and 3) debriefing and evaluation procedures after a session.

245



Before the session

- Clarification of intention and development tasks for the session
- Choice of exercise modality, duration, intensity and terrain/facility
- Presence of coach and training partners
- Decision of internal and external feedback to adjust execution of the session, for instance to control intensity or improve technique and tactics (e.g., heart rate, speed, lactate, RPE, video, feedback from coach and peers)
- Plan for timing and amount of nutrition and fluid intake prior to, during, and after the session
- Choice of equipment and clothing
- Mental preparation procedures

During the session

- Continuous control and micro-adjustments of training intensity
- Adjustments of other loading factors and equipment, if necessary
- Mental awareness and focus on pre-planned development tasks
- Intake of nutrition and fluid according to plan (or necessary adjustments)
- Feedback from coach and/or peers according to agreement

After the session

- Initiation of the recovery processes immediately after the session (e.g., shower, dry clothing, nutrition, fluid, rest)
- Immediate debriefing procedures
- Evaluation of physical, technical and psychological factors:
 - Accordance between intention and execution (e.g., intensity, technical quality, focus)
 - Were appropriate adjustments undertaken?
- Discussion of appropriate adjustments in the overall training process and for that specific type of session