

## Sports - Part 1

Welcome to Module 7. Today we will be looking at the application of human movement science principles in sports. So we have yet looked at fundamental movements, exercise, the integration of different fields of functional anatomy, biomechanics, and motor control. So today we will be looking at how do we apply all of these fields in the sporting examples and we will also look at parasport. So let's look at some of the learning outcomes for this module. So we will be applying human movement science principle to sport.

We will look at some of the important considerations. We will look at movement analysis of sporting skills. We will look at two examples. So we will take you through the exact protocol that we have planned and you can use that as an outline for in your own sport or if you are a coach or a sport scientist. And then we look at some of the considerations of how you would apply these principles to parasport.

So what are some of the considerations? You need to make sure that this course or you understand, let's scrape that, you need to understand that this course is obviously a brief or a narrative overview of applying all of these principles in order to go deep into the variables, how to calculate them, what are the actual calculations, of course is a longer period of study, right? So the, as we all know, the intent of this course or this module thereafter is to give you a brief understanding of the philosophy, the principles, how do you look at it to give you a perspective or to create that curiosity, what human movement science is. So let's look at some of the sporting considerations. So the field of human movement science, the principles are quite crucial. So they play a crucial role in the field of sport performance, training intervention, so specifically when you're designing training protocols and injury prevention as well. So it's as important for performance as it is for injury.

And these principles that are derived from the study, so we've looked at the integration and we'll be looking at them in the next few slides as well, comes from the study of biomechanics, that is kinematics and kinetics that you'll be learning in the previous modules, motor control that you've learned in module two. And you've also looked at functional anatomy, right? Now do bear in mind that there is a lot of physiology involved as well, but for the purpose of this course, we have not included physiology, it's pertaining to only the muscle physiology or the skeletal physiology. However, there are additional units that are attached to this course of sport science, and you can have a look at them for detailed information. We've also touched briefly into what coaching science is, and some principles of coaching science haven't got really into the depth as it's a field in itself, right? And so how does the integration of all of these four, five, which we'll see in the next few slides, have significant implication for athletes, right? So for you, if

you're an athlete or a coach or a sports scientist, right, it's quite important for you to understand these. Right, so let's look at some of these integrated disciplines.

So as we've looked at, if you look at in this figure quite quickly, HMS is a human movement science, and when you are considering it for sport, apart from physiology, these are your major disciplines where you would draw some of the principles or considerations from. Now, how exactly we do this, what questions do we ask when we're doing the analysis? We look at them in the next few slides, right? But for our understanding, coaching science, biomechanics, motor control, and functional anatomy, all of them play a huge role. So if you're a sports scientist or performance analyst, you need to have an overall understanding of all these four fields. What does it entail? What are some of the important characteristics and considerations from all of them, right? And if you're a coach as well, you need to have a touch base on all of this.

Okay. So let's look at some of the movement analysis considerations from the discipline of biomechanics. So we've known by now what biomechanics is. It's the study of human movement using physics and mathematic principles. You study the mechanics component in the movement. We have looked at kinematics and kinetics, which are the branches in biomechanics.

But how do we consider, right? So if you are looking at skill analysis or movement analysis, the first thing we start with is your needs analysis, right? Now this is quite important when you're doing a physiological analysis as well, or if you're doing any kind of analysis, you first need to understand what are the needs of the sport, right? And we've looked at needs analysis in the previous modules. So this module you will see is a compilation of all that you've learned in the previous modules and how do we apply that to sport. So quick brief on needs analysis basically looks at the needs of the game or the demands of the game, right? So we will be scribbling a lot today where there's no information we'll be discussing and writing them down, right? So pay attention to how we're going to be doing this. So needs analysis, so demands of the game. So they could be physiological demands, psychological demands, mechanical demands, all of them, right? So you need to understand what's the underlying characteristics.

Once you have done the needs analysis, you need to define what's your goal. So what could be an example of a goal or an outcome? For example, you are a fast bowler, right? And we'll be looking at that example shortly. But if you're a fast bowler, your aim could be to increase speed, which is to bowl fast, right? What could be another aim? So say for example, you are hitting a forehand when you are playing table tennis, what could be the different goals? It could be speed again; it could be spin, right? Or it could be direction, right? So all of these could be your different goals. So when you're studying a skill, once you've understand, understood the needs of the sport, you then get into what is the need or the aim or the outcome variable that I'm looking at, right? So once you've defined

your goal, right, and you have an outcome variable, you break the skill down into phases. And we've looked at phasing analysis, which is pretty much right here, which is pretty much it's chopping the skill into chopping into subsets, right? So it is subsets of information or subsets of the entire timeline, right? So you're chopping them into these smaller phases.

Sometimes if the skill is too complex, you also chop the phases further down into sub phases, right? And in those sub phases, we look at event of interest, which as the name suggests, is the interest where it's a moment in time, which is key or important. So that's our event of interest. So now that we've looked at what are the needs, what's the goal, what are the phases from the phases now within these phases, what are our key variables? So it could be kinematic variables, for example, and these could be angles. So we could be looking at joint angles, or it could be kinetic variables, for example. And these could be looking at force production or distribution.

So I'll just write force profile. It could be also looking at energy flow, could be looking at segmental interaction as well, right? So all of these are some of the variables that are key variables, could be key variables if you are analyzing a skill. You could also have anatomical variables or functional anatomical variables, which is could be looking at if there is any discrepancies. Or you could also have a look at range of motion or mobility. Right? So all of these are different variables you need to define based on your goal or what your outcome variables is, outcome variable is, you need to decide what are the key variables, right? Now this information comes from reading previous research, what's been established in the literature, or if there is any ground for why you would look at that specific variable as well, right? So it's quite important that your key variables answer your outcome or your goal.

What are some of the other movement analysis considerations? So now that you've got your key variables, you then look at how do I achieve these key variables, right? So it could be from different tools and techniques. One of the tools, just do that. One of the tools could be, now we've looked at this in module 5, so let's take a few examples here. You could look at video camera, so that would be your qualitative analysis, right? So that's for qualitative analysis. You could also use 3D motion capture, which is your Vicon cameras or your Qualsys cameras.

So that becomes your quantitative analysis. And we've also looked at, you know, using computer simulation models. Computer simulation modeling, right? So we have looked at that as well to understand performance patterns or injury patterns, isn't it? And that becomes your simulation or your predictive modeling, right? So these are some of the different tools or techniques that you could use, right? And your tools of course then become cameras, sensors, along with 3D motion capture, you could use sensors as well, depending on where you're doing the analysis and what do you get out of it, right? So

these are some of the tools and techniques. You would then, once you've identified your tools and techniques, you collect the data, you're then looking at statistical analysis. Usually the common statistical analysis we look for are mean.

You would also look at the distribution, right? And then also look at correlation. So how does one variable correlate with another? And of course, again, statistical analysis is something that we've not covered. We do know the importance of that when we're looking at data and we're dealing with numbers over here. So we would obviously have, you know, basic knowledge of statistics is absolutely required for the boundary and for the duration of this course. Of course, we have not covered statistical analysis, but do look into it if you want to proceed further into this area, right? Extremely important.

So it could be correlation analysis, it could be regression as well, just few things that you would often find, right? So distributions. So these are some of the statistical analysis. Then once you've looked at your, you've collected your data, you've done your stats, what you are actually looking at is your movement patterns. Now these movement patterns could be for performance, right? So they could, you could be looking at performance patterns, or you could be looking at injury, risk of injury, right? All of those patterns or technique compromises because of an injury that's happening. So when you're looking at performance patterns, again, going back to your key variables, it depends on what you're looking for.

Sometimes you don't know what you're looking for and you're trying to find out relationships within the data. And that's where we will get into module eight, where we talk about new techniques of AI, machine learning, where we try to understand complex data sets, where we try to understand what relates, you know, without giving it labeled information. So that is what we look at in performance patterns. However, in injury profiling, sometimes, or injury patterns, when you're looking at them, sometimes you can look at how is loading happening. So you can look at loading rates, for example.

And loading rates also give you what's the stress on the joint, right? So if you are having, say for example, increased amount of compression stress, right? Just one example, it is not the only thing. So if you're having compression tests, for example, stress, or, you know, let's take an example of the knee or on the spine. So if you are having a lot of stress, go through the spine and that is happening repeatedly. So there is intensity, frequency, all of that. You are going to be, you are going to have higher probability of tendency to be injured, right? So hence looking at loading rates or loading patterns is quite important to detect injury patterns.

All right. And you could also be evaluating technique if technique is good, bad, you know, if it is leading more towards, if it's going to improve your performance or if it's going to hinder you because it is, you know, incorrect or there are ways of improvement.

So looking at movement patterns, performance and injury, and then of course, analyzing the technique as well. What you could also do is look at fundamental movements. So we've covered fundamental movements, exercises, motor control, gross and fine motor skills, which are the subset of what you find in sport, right? So once you understand what skill you are looking at, maybe try to trickle it down to what basic movement pattern does it follow? Is it, is it a basic modified pattern of catching? Is it a basic modified pattern of throwing? For example, if you're looking at baseball pitching, you could look at throwing mechanics, you know, if you're looking at, you know, basketball, for example, where they jump from a single leg position, you could be looking at single leg squat as some of the fundamental movements, right? So if you understand what's the building block, so that's your fundamental movements. So what are my building blocks for that particular skill? Right? Then that is when you can start getting into how do I break down this complex information? So building blocks help you design foundation, right? So that's where your foundation comes from.

And once you have a solid foundation, it then becomes easier to adopt or adapt sport skills, right? Easily. So these are some of the considerations for biomechanics. Another important one would, which would come from biomechanical engineering or sport engineering would be the equipment adaptations, right? For specific sport, you can, or you do have the ability to design the equipment according to you. So it could be maybe choosing, you know, a tennis racket, for example, the grip size would be different for everyone. So you could have a choice of what grip do you choose? How many over grips would you have? What is the tension of the strings on the racket? It could also be the size of the racket frame.

So let us write some of these down. So if, for example, you're looking at tennis rackets, you could be looking at grip size. You could also be looking at racket head shape and size. Then you could also have modified tension in the strings.

These are some of the examples. If you, if we take another example, say of a cricket bat, again, that gives you scope to change your equipment's specs. So you could have long handles. It could be change in handle size. It could be the weight of the bat. It is the same for the racket as well.

So weight of the bat, you could also have change in grip. Okay. And say, for example, if you wanted to put any over grips, right? So these are some of the examples where you would have, you know, movement analysis considerations and how you would analyze movement. What are some of the things that you would look at? So these would be from the biomechanics perspective, right? So let's look at some of the movement analysis considerations from the functional anatomy perspective, right? So for functional anatomy, as we already know, it's the integration of how the musculoskeletal system interacts with each other, also with the neuro system, so nervous system, right? And how

those three together produce movement. So what would be important in that scenario is to understand what's the joint action.

So if you're looking at any kind of a sport, say, for example, you're looking at throwing, right? So it could be baseball pitching. So what's the joint action? What are the major joints? So you would look at the major joints, right? That are in action. So you would label them. Next thing you would look at now that you know what joints are in action, you would look at the muscles involved. So is it a singular muscle involvement, which is never the case, right? It could be a single muscle dominance, but never a singular movement.

So what muscles are involved? And with what muscles are involved, usually it is multiple. So multiple muscle involvement, singular is no, multiple is yes. And what are their roles? Right? So is it when we say roles, is it acting as a prime mover? Is it acting as an antagonist? Or are they acting as stabilizers, right? So what is the muscle role? It could be one of these three. Now we need to understand as much as fundamental movements and your exercises or your final gross motor skills might seem as simplified movements, right? So most of them are simplified. When you come to sport, it's quite dynamic, right? Your movement and all that you're doing within a scale that constitutes the scale is quite dynamic.

So you won't be able to exactly point one right, this is happening in the sagittal plane or the frontal plane. They could be different movements happening at the same time in different planes, right? So that's why it's a very dynamic or a complex thing to do. But the purpose of movement analysis is to identify what are the dominant movement patterns, what are the dominant muscular patterns, what are the dominant muscles that are being used? And we could do that to an extent, right? So now that we've looked at joint action in the muscles involved, the next thing to do is for these movements, what is the contraction, right? Now we do know that if it's a prime mover and it's moving or moving the arm, it's usually going to be concentric. So type of contractions, sorry, probably not a good idea to write here. But type of muscle contractions could be concentric, could be eccentric, that's what we're talking about, or could be isometric as well, right? So could be any of the muscle contractions.

Once that you've known what the joint action is, what muscles are involved, what is your role and the contractions, we then look at what's the strength in the muscle, right? So if you are for example a gymnast, right? And we understand that you are going to be, say for example you're performing a backflip or you're doing a backflip on the bar, right? On the beam. You need to understand the muscles involved would be shoulders, it could be the elbow joint, there's a lot happening at the wrist. So do I have enough strength, right? So only it's when you start breaking down this movement, you can then understand where the strength needs to be built. So you probably need to have, you know, good

shoulder strength because it is weight bearing, right? It could also be that your wrists are also in the same position. So you understand what are the demands, what are the needs in that scenario, right? So that's increased muscular strength.

Through this strength, do I have enough range of motion, mobility and flexibility, right? Now for example, if you're doing a badminton smash, you're always going to be in that position where there's extreme amount of back extension, right? When you're reaching out for that smash and you're smacking from there. Now to be able to be in that position, you need to have good range of motion. So that is strength that needs to be executed. So strength that needs to be executed from extreme range of motion, right? So do I have that range of motion? Can I achieve that? Can I execute strength from that, right? Do I have the mobility and the flexibility around that joint, right? So these are some of the questions you would ask. Also, last but not the least, some of the major considerations would also include anatomical discrepancies.

Now these are quite important. Let's just revise what discrepancies are. So discrepancies is nothing but your abilities, right? So if you have limited or reduced abilities, right, due to anatomical discrepancies that need to be identified sooner. It could also be the strength difference between limb to limb. It could be the limb length between limb to limb. So we have all of these different components or considerations that are quite important when you're looking at them from the functional anatomy lens.

So we've looked at biomechanics and we've looked at functional anatomy. Let's move to coaching science. So in coaching science, the important thing would be for the coaches to have session planning, right? So how would you plan a session? Again with the planning, you would start with what is your aim or your goal for the session, right? That's the first thing you would start with. What is the skill that you're focusing on, right? So the skill for example you're focusing on sometimes it's more than one, so it is skills. Are you working? So is your goal more technical? Is that what you're working on or is it more tactical, right? And further within technical, is it to improve technique? So that's an arrow for improve.

So is it to improve technique? Is it to improve accuracy? Right? Or is it to build consistency? So there could be different you know aims or goals of the session. These are some of the aims for you and through this what is the skill? So for example I'm working on you know the technique of my serve or it could be I'm increasing the accuracy of the ground strokes or it could be improving consistency of bowling performance. I mean I'm looking at consistency of pitching, right? Or consistency of strokes for example in swimming. So all of these could be different you know when you're doing a session plan specifically for the coaches, you have to look at what is the aim or the goal or what skills are we looking at. Now that we've identified that, you also

need to set intensity, right? So you need to set the intensity which is your frequency, your workload, quite important.

So that's what you would design, right? For this you would design your drills. If you would design any drills or gameplay, right? You would do session planning accordingly. Now why would this be important? Intensity, frequency and workload is make sure that as even as a coach and you're not training your athletes that goes to the strength and conditioning side, you need to make sure that you're balancing and having good communication with your strength and conditioning coaches. So if they are having a heavy session in the morning, you are not repeating the same thing and you're not putting overload, you know, scrape that, you're not overloading the athlete, right? So it's quite important to understand intensity, frequency and workload of all of these sports science professionals that are working with the athlete. Another important thing would be in that scenario once you've started looking at technique improvement specifically, you need to be able to bifurcate it into what is technique, skill and style and we've looked at this in the previous modules as well.

So for example, if I'm taking an example of, let's take an example of a tennis forehand. As you can see, tennis is my sport, so we keep coming back to the same example. Right, so let's take an example of a tennis forehand. If you're hitting a tennis forehand, what would be your technique? Right, so your technique would be segmental interaction, right, segmental, sequential interaction. It could be, you know, rotation, right, so your pelvic or, yeah, rotation and then you move into using the shoulder and hip, you transfer it into your racket speed, right.

Now that could be some important technique. However, your, right, so that could be an important technique. However, your style, right, your style could be the way you stand, your foot placement. That could vary between individual, right. Foot placement could vary, your backswing could vary, right. Whether you jump or not while you hit the ball could vary, right.

So that's an example, isn't it? So all of these are majorly based on style. Whether it's important to generate speed depends on what's your overall technique, right. And the skill here would be the tennis, oh sorry, yeah, skill here would be the tennis forehand, right. So even while having a forehand, you could have different foot placement, different backswing and you could also jump or not and play.

You could also have different stance, for example, right. So you can have different ways of standing as well while you approach the ball. So all of these are different style characteristics, whereas your technique would still remain the same, right. So that is what it would remain. So you need to be able to identify as a coach, is it the style, is it the technique or is it the skill that you're working on.



And accordingly, once you've done the session planning and you also know the differentiation between technique, style and skill, you can then understand what are some of the teaching cues. So for this, you need to have your athlete understanding, right. So you need to understand your athlete. So when I say understand, it could be how does your athlete learn, right. Is he an independent learner, right, or he needs to be fed again and again.

Based on that, you would decide what feedback to give or how to give the feedback, right. So learning and feedback, the questions that you're answering is how, what and when. So quite important as coaches to understand these, right. And then once you know your teaching cues and all of that, your teaching cues also will dictate if they're able to understand it better, if they're performing better, you would then progress them, right.

So this could be increase in intensity. If you take, sorry, if you take the same example, if you're working on technique of the tennis forehand and your athlete is performing it well, there's good technique, you would then increase the intensity, maybe get them to have more drills or have them in rallies, right, or have them in game plays. That's why you're increasing the intensity. Or it could be to increase complexity of where they would have it. So maybe have a running forehand, right, or have, you know, them play it in a match, right, or in a game play, a practice match. If not, how would you regress? You would go back to working on their technique.

You would break it down and you would go back to working on these little things that you need to fix in their technique before you progress them further. So as a coach, you can see that how these considerations help you to design your session planning. And at the same time, you are using information from biomechanics, using a little bit of information from motor control. So there's biomechanics here. You're also using skills from, you know, game play or coaching science, right, which we've looked at.

Sorry, coaching science and lots of physiology here. Right. And then when it comes to progression and regression, you're also taking into account your functional anatomy. You're also looking at biomechanics, pretty much everything, isn't it? So a combination of everything that is helping you decide whether you need to progress or regress. So these are some of the considerations from the coaching science perspective.