

Optimizing throws and analyzing t-v-diagrams

time	phase/topic	phase content	social form/method/ material	App/material functional requirements	Expectation of Students behavior
Module 1: Sports lesson 90 minutes (60 min net) - getting to know the sports equipment					
10 mins	warming up the muscles	Functional warm-up to prevent injuries: throwing with special attention to the shoulder (e.g. 10 ball, catching a pass, etc.)	ball	-	
10 mins	practice 1 Getting to know the sports equipment/me dium experimentally (inductive procedure)	The pupils try different throws/shot put forms with the medicine ball by trying out different movements, including own movements. Task: Try as many possibilities as possible to achieve maximum distance. Try at least 4 variations.	tandem work Medicine ball, as small as possible (without sensor) Pay attention to safety, only throw as many times so that you don't strain yourself. Students lined up in rows.	-	- Throw - Spin movement, horizontal and vertical - rotation of the body - Bump - With a start - No attempt - One-handed, two- handed - backwards (shock)
15 min utes	Process	The pupils discuss the determining factors for the throwing distance based on the experiences made. Task: Name the throwing technique with which you can get the furthest. Explain why this technique is particularly good for achieving great distance.	class discussion , The teacher draws attention to the angle and throwing speed as the determinants of large distances using questioning techniques.		-Students use simple terms - Various techniques make the most sense (depending on the weight of the ball, the strength of the pupils...) - drop height - Necessary conceptual fields: angle,

					acceleration
Joint location: Instructor presents angle as the first improvement factor. Set up the video device and a measurement marker					
25 mins	practice 2 Introduce shock as a rule	The students know the rules of the shot put discipline with regard to the execution of the movement. The pupils throw the ball without a run-up and observe the effects of different throwing angles on the throwing distance. Task: Kick the medicine ball at different angles. Observe the effects on the shot distance. Record your observation as a video comment.	teacher input, Rules of Shot Put Sports equipment, marker for measuring the throw distance, mobile phone/tablet for recording the throw (tripod) Work in groups of 4 (about 6 digital devices). Recording of 3 different angles by one person in the group (flat, steep, average) Sensor ball, smartphone/tablet, app In the meantime, class discussion about experiences possible (intermediate reflection)	- Storage capacity of the tablet as a critical point - Instant video replay (without upload)	
homework					
	video analysis	The pupils look at the recorded videos and analyze them with regard to the best possible throwing angle. Assignment: Analyze the three videos of your group under the question at which angle the medicine ball should be thrown.	App should include a protractor. Alternatively, work with screenshot and protractor.	<i>The Students watch their videos from the sports lesson</i>	All angles equal; all angles different; Body height...The optimal angle of impact is around 45°. For Students with a lot of power, the angle didn't have a big impact, they kept pushing the ball despite poor technique. The same for Students with large height

time	Phase / topic	Phase content	Social form / method / material	Functional requirements for app / material
Module 2: Physics lesson 90 minutes - introduction to the topic				
Lesson 2A) Evaluation with vocabulary work (scientific terms) Goal: The students use technical language to describe and evaluate the throwing processes <i>Interim goals: The students ...</i> - Describe the flight curve based on the videos of the sports lesson - use scientific terms in an appropriate manner (e.g. speed, altitude, distance)				
5 min	Inquire	Teacher leads from the sport to the physics lesson. Students each tell a sentence about the last sport lesson in a reporting chain by naming events and findings about the movement.	teacher input, reporting chain	-
10 min	Gather	<p>The teacher discusses the homework from the sports lesson: video analysis of an ideal movement. They will present a selection of video comments so that the pupils can talk about their ideas and receive feedback. The concise description by the pupils takes place in the think-pair-share procedure. (individually formulate ideas and then exchange ideas with partners / groups)</p> <p><i>In the work order (or via help cards) some concise terms are built in which should be used as far as possible. [Flight curve, altitude, distance, speed, force, ...?]</i></p>	Think-Pair-Share Video commentary	<i>The pupils see each other's selection of video comments. On the basis of these comments, each pupil thinks about a description of the optimal movement in native terms. The pupils share this description with each other in the group and agree on a result.</i>
5 min	Process I	<p>Teacher and pupils agree on a common description and divisions of the throwing phases.</p> <p>Result: formulation of a concise (optimal) movement sequence.</p>	blackboard Teacher-student conversation (class discussion)	-

15 minutes	Apply	<p>Teacher provides some exercises in which the terms and knowledge are consolidated in similar / different contexts.</p> <p><i>Example: Describe water fountains and their flight curves; Ski jumps; ...</i></p> <p><i>Addition: highlighting special features compared to the student's own throws. (E.g. continuous "throws" in the case of water, strong wind influences with ski jumpers, ...)</i></p>	Heterogeneous group work	- Students look at the provided image / video material
10 min	Process II	Students compare and discuss the results. Possibly clarify incorrect use of terms by the teacher.	Smartboard / student lecture class discussion	

Lesson 2B) Diagrams and sensors

Goal: The students read data from the diagrams and compare the presentation and movement of the throwing module

Requirement:

- first experiences with diagrams (e.g. mathematics, assignments)
- xy diagrams? (Path-height diagram)

Difficulties:

- Transition to t-v diagrams (graph shown is not visible in the movements)
- o Advantage: Since the movement parallel to the ground is approximately uniform, there are no major differences between the representation of way (s) vs. time (t) on the x-axis.

5 min	Inquire (Referencing previous lesson)	<p>The teacher picks up on the knowledge from the first sports lesson that the "start speed" is an essential variable that influences the flight distance.</p> <p>The teacher describes that the sports equipment, including the sensor, is available and at first roughly presents the properties. This allows the launch speed to be measured and also how the speed changes during the flight.</p>	Teacher Input class discussion	
15 minutes	Gather	<p>Teacher demonstrates video-based sensor data acquisition with simple movements and the shape of the diagrams. Students perform some of the movements mentioned and write down / describe the resulting diagrams (each group can then carry out experiments in freestyle and note the results):</p> <p>The students compare movements.</p> <p>((You can find example images/graphs at the end of the document and more in the complementary PowerPoint Slides))</p>	class discussion Group work / student experiment	<p><i>Sensor transmits the collected data live to the app. The app evaluates this and displays the data as a diagram.</i></p> <p><i>The data generated by the sensors are shown in the app as a diagram. The presentation in turn is described by the pupils via video comment.</i></p>

5 min	Process	Students present the results. Students and teacher discuss these and record key messages.	Smartboard / student lecture class discussion	
15 minutes	Apply	Students apply the new knowledge (e.g. in exercises for consolidation; quizzes; making predictions; evaluating diagrams, making predictions about described throws, assigning diagrams to movement descriptions / pictures etc.). Students describe the movements component by component	Individual work class discussion	<i>As an already existing task in the app: video (s) with graphics (s) is already included, including the task.</i>
5 min	Process	Students present their results from the GA / SE and discuss different answers if necessary: Students discuss the assignment of movement processes. The teacher gives a brief outlook for the next sports lesson.	short student lecture class discussion	-

Module 3: Sports lesson 90 min (60 min net) - video and sensor data-based performance improvement				
10 mins	warming up the muscles	Functional warm-up for injury prevention	form of play in the group	expected student actions
	Practice 1	The students push the ball several times in a row with a similar throwing angle. Task: (You know from your last physics/math lesson the optimal throwing angle for the greatest possible distance.) Execute at least three throwing movements to achieve the optimal throwing angle. Use video analysis as a tool.	group of 4 Sensor ball, smartphone/tablet, app	<i>The students create a video with the app. The students watch the video shortly afterwards.</i>
	Practice 2 How do I increase the launch speed	Assignment: Discuss possible ways to increase the launch speed	group work	<i>Planning, swinging, rotating</i>
	Process	The Students know the technique of gliding in the shot put and practice it. Task: Use the technique of gliding.	group work: Technical training - This is what the right technique looks like.	<i>Performing the technique in groups of 4</i>
	Apply	The Students practice the technique of gliding (shot put). The Students improve their technique by analyzing sensor data. Task: Practice the technique of gliding. Analyze the sensor data for the purpose of improving the technique.	groups of 4. The students push the ball and analyze the data in groups Sensor ball, smartphone/tablet, app	<i>The Students carry out the push. Pupils look at the generated diagram shortly afterwards.</i>

Homework

10 mins	Process (reflection)	<p>In tandem, the pupils reflect on the effects on the data-based movement improvement, keeping in mind their movement experience and the video diagram recording (their best movement result).</p> <p>Question: Did the video chart comparison help you improve your movement performance gain; justify? What helped you with the analysis? Where did you encounter difficulties in the analysis?</p>	smart phone, app	<i>The pupils look at the videos created in the lesson together with the sensor data in the diagram. The pupils comment on their video on the one hand and give feedback on the tandem partner's video comments on the other.</i>
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Module 4: Interdisciplinary classes in sports and physics
 Effect of various influencing factors on the sporting result

Lesson 4) Data evaluation & summary

Goal: The pupils can safely take data from t-v diagrams and assess them

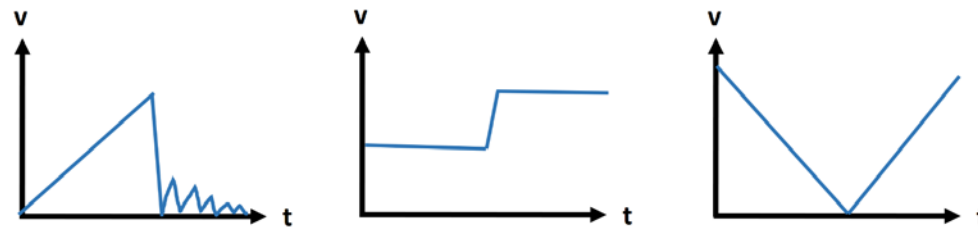
5 min	Inquire	Repeat the influencing variables makes it easier to evaluate the data in a targeted manner. (Evaluations from 2nd sports lesson for example)	-	-
15 minutes	Gather (diagram analysis)	Teacher provides videos of top athletes who use the sensor balls for different throwing techniques (experimental assignment. Sometimes movement and diagram have to be assigned; sometimes only one thing is available and the rest has to be added yourself). Task: Compare the movements of the athletes and assign the diagrams. You can also simulate the movements of the athletes using the sensor device.	class discussion GA	<i>Students assign motion videos to their corresponding diagrams and vice versa. Students try using the motion videos and the associated diagrams to reproduce them as closely as possible using their own recorded motion sequences. The comparison between own video + diagram and the ideal video + diagram serves for reflection.</i>
5 min	Process (diagram analysis)	Students explain their assignment in a well-founded manner and discuss different answers if necessary.	short student lecture class discussion	-
10 min	Apply	Students discuss the application of the analysis options (e.g. also comparison of different techniques)	class discussion	-

Reflection, playful ending, evaluation (45 min.) - Some options:

A)	Data comparisons	<p>Students see data such as throwing distance and throwing speed from their diagrams.</p> <p>They compare the values from the end to the beginning of the sequence in order to assess the increase in performance. (In addition, the overall performance of the class can be worked out as well.)</p> <p>Likewise, more subtle investigations are possible, for example, that there was no drop in speed before the launch.</p>		The app allows access to the litter data of the second sports lesson or there is an overview with the litter ranges from the first hour.
B)	Quiz (e.g. Kahoot)	<p>Group surveys in which essential questions from the teaching unit are asked. (Evaluate statements, fill in gaps, assign diagram, physical questions, ...)</p> <p>Points for quick and correct answers.</p> <p>With percentage results, the teacher also receives quick feedback on which aspects did the pupils got a better understanding and can address them in the rest of the lesson.</p>		
C)	Throwing games	<p>A throwing game in which athletic performance and skills from the STEM area are helpful (e.g. logical thinking, physical understanding, etc.)</p> <p>An example: pupils throw 5 times. In doing so, they must reach a target distance as a sum (e.g. 15 meters). You can decide whether the next throw result should be added or subtracted.</p>		List of values one after the other. If necessary, the calculation can be done by hand. Which values are relevant depends on the game.

Reflection / feedback on the project / lesson				
10 min	Reflection / feedback on the project	Reflection on the 4 double lessons; Topics: 1. Learned athletic techniques 2. Improvements in your own performance? 3. New experiences of the laws of nature? 4. Dealing with technology	Single work	Evaluation sheet

Example diagrams of movements (1st free fall / 2nd roll + 2nd push / 3rd throwing upwards + fall)



Depiction / sample diagram of the shot put:

