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Effective Learning in Virtual Conferences: The Application of Five Principles of Learning

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ABSTRACT

In this article, we examine the adaptation of learning among scientists and healthcare professionals in conferences and symposia from face-to-face to fully virtual meetings accelerated in the last years. Advantages and limitations for both settings have been described in different research studies but the effectiveness of learning can be reflected similarly by applying five fundamental principles of learning, which are based on empirical research in cognitive psychology. From a practical context, we compared the individual learning outcomes from two satellite symposia conducted face-to-face in 2019 and virtually in 2021 at the European Congress of Urology, EAU. Although both conference formats were almost identical, the five principles of learning were applied in both symposia. There were also some differences due to adaptation to online conferences, and our findings suggest that the virtual conference was perceived as significantly more effective than the face-to-face conference on all five criteria, and digital learning is a valid alternative to face-to-face conferences. What still needs to be better understood and analysed is the informal learning that is taking place during conferences, but suggesting an active design of any digital event by combining "technical literacy· with "learning literacy" will enable us to better analyse and study the impact of learning using the five learning principles in the design of other events in the future.

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Introduction

Background

Medical conferences and seminars have always provided important opportunities for sharing and discussing scientific knowledge among scientist and health-care professionals. Besides the central objective of knowledge dissemination, these events provide significant opportunities for social interactions and networking. In recent years, however, the landscape started to change. Whereas these events were traditionally conducted face-to-face, many are now conducted online or in a hybrid fashion [1,2]. Although the shift from face-to-face was accelerated due to the COVID-19 pandemic, changing to virtual events was on the agenda for quite some time [3]. This was mainly due to technological advancements, such as better internet access and speed and the availability of user-friendly virtual meeting software, such as Zoom, Skype, Microsoft Teams, and FaceTime.

There are significant advantages of conducting conferences and seminars online in a virtual environment. According to a recent review [4], virtual events have a number of advantages. First, no travel is required, which equates to significant savings in transportation and accommodation costs [4]. In addition, registration fees for virtual conferences are generally cheaper and sessions can be accessed anywhere with a variety of devices ranging from computers to hand-held tablets and smart phones [5]. As a consequence of the easy access to virtual events, they have the potential to ease social inequalities, since easier access allows disadvantaged individuals to participate in the scientific discourse, independent of gender, race, geography or social status [6–8].

There are also some downsides of conducting virtual events. Sometimes, there are technical glitches that limit accessibility and differences in time zones make it difficult to attend for participants at the same time from different parts of the world. It has also been noted that participants, who attend virtual events are easily distracted by work-related matters (emails need to be answered) or home routines [9]. There are also difficulties in reading non-verbal reactions from presenters and the audience, which can make it a less interactive

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experience. All in all, however, virtual conferences have successfully been implemented in many disciplines and since the COVID-19 pandemic, there is growing evidence that it is a feasible approach and is here to stay in one way or the other.

With many organisations moving towards virtual events, research has sprung up documenting this transition [9–11]. Besides these mainly descriptive accounts, there are now also papers that provide practical suggestions and tips to consider when planning and executing virtual events [7,12,13]. However, largely missing in the literature are accounts that focus on principles that enhance *learning* during such events. Arguably, learning is at the heart of all conferences or seminars. Presenters share new insights with the audience and engage in an active academic dialogue, which constitutes learning on a large scale. Many activities at conferences and seminars are intuitively directed towards enabling learning (e.g. team challenges, interactive presentations, breakout sessions), but a formal framework is often missing. A fundamental question that needs to be addressed is, how do people learn during conferences or seminars and are there any differences between face-to-face events and virtual events that need to be considered? It is possible that learning in virtual events is impaired due to lack of face-to-face interactions that significantly limit attendees' ability to acquire new knowledge and insights.

The objective of the present paper was to make a first attempt to address these questions by providing an overview of five fundamental principles of learning. We will briefly explain how these principles can be applied to face-to-face events as well as virtual events. We will endeavour to do this from a practitioner's perspective by referring to an actual large-scale conference that has been conducted face-to-face and virtually. Finally, we will present empirical findings that provide first insights in the effectiveness of transferring the conference to a virtual event. We will end the paper by elaborating on the findings and proposing future avenues for research.

The Five Principles of Learning

The five principles of learning adapted for this study, were derived from the active-learning literature, particularly from the research on problem-based learning [14]. Problem-based learning is an effective instructional method for adult learners and is anchored in research on how people learn [15,16]. From this body of research, we extracted five key learning principles, which we believe provide an adequate blueprint for evaluating learning at educational conferences and professional development programmes. See Figure 1 for an overview of these five principles and their suggested overlapping characteristics. We will briefly summarise these principles below.

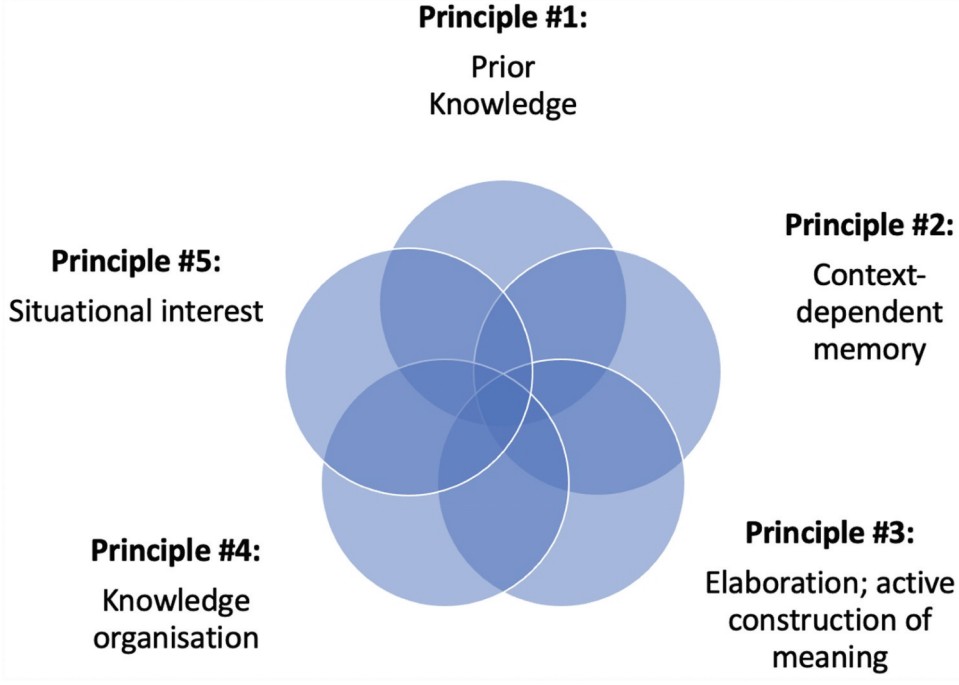

Figure 1. Five principles of learning with their overlapping characteristics.

Principle #1 the Role of Prior Knowledge

A common misconception is that learning constitutes "filling empty vessels with knowledge". All individuals have knowledge stored in memory, referred to as prior-knowledge. Learning is activating this prior knowledge first and then linking new information to this knowledge. Only if prior knowledge is activated, new information can be assimilated into the knowledge structure of the learner. See, for example [17–23].

Principle #2 Context-dependent Memory

Learning happens in context. If new information is presented in an abstract form, without context, it is difficult to assimilate this information into memory. Providing context enables the learner to (1) better understand the new information (e.g. providing examples) and (2) part of this context is encoded together with the newly acquired knowledge (e.g. a patient example of a medical condition). The fact that acquired knowledge is more likely to be retrieved in the context it was learned, is an important learning mechanism. See, for example [24–29].

Principle #3 Elaboration: Learning Is an Active Construction of Meaning

It is not sufficient to merely present information to learners and assume that the learner will remember that information. Even if examples are provided and prior knowledge is activated, it is no guarantee that learning will be successful. Learning is activity during which the learners deliberately construct their own meaning by making sense of every piece of information and linking it to what they know. This also includes elaborating of what one knows and what one does not know about the topic in question. The latter is a powerful mechanism that is often a successful element in the construction of meaning and understanding. See, for example [30–39].

Principle #4 Knowledge Organisation: Memory Storage and Retrieval

In its simplest form, knowledge is organised in semantic networks as concepts. Concepts are linked with each other via propositional statements. Memory retrieval is activation of a concept and activating linked concepts in that network (spreading activation). If knowledge becomes specialised through experience and many years of expertise development, memory network structures can be encapsulated to increase storage and re-activation efficiency. Note that knowledge consolidation in the brain takes time. See, for example [40–44].

Principle #5 Situational Interest

Finally, learners must be willing to invest effort and be motivated to learn. Situational interest is a powerful mechanism that entails arousing a learner's interest in the moment (situation) by providing a learning stimulus, such as a problem, presenting new and incongruent information, or presenting unexpected causal events. Situational interest is activated by learners realising that they have a knowledge gap regarding the stimulus presented. It has proven to be a powerful mechanism that leads to information-seeking behaviour (i.e. learning) to close the knowledge gaSee for example [14,45–52].

Before we provide an example of how these five principles of learning can be applied in a real-life context, it should be highlighted that these five principles should not be considered in isolation. Instead, they are intertwined and closely related with each other. For instance, prior knowledge can be activated by means of arousing situational interest. If learners are presented with an incongruent problem or puzzle during the start of a learning event, they will activate their prior knowledge (Principle #1) from memory (Principle #4) and elaborate what they know about the problem (Principle #3). The problem provides context (Principle #2). If they come to the realisation that they have a knowledge deficit with regard to the problem at hand, their situational interest will be triggered (Principle #5), which leads to a desire to find out more about the problem until they know the answer. This in turn leads to learning which represents consolidating new information into memory (Principle #4).

Are There Significant Differences in the Principles of Learning between Face-to-face and Virtual Events?

Returning to the question whether learning is fundamentally different between face-to-face and online learning, there seems no reason to believe that there are substantial differences in the application of these five principles to face-to-face and virtual learning modes. For learning to be successful in the virtual context, learners still need to be provided with a context to activate their prior knowledge, be situationally interested and engaged in active construction of meaning. Hence, from the psychological perspective

it appears that all five principles of learning apply when engaging in a face-to-face event or a virtual event.

Application of the Five Principles of Learning to a Real-Life Conference

As example we selected a satellite symposium conducted in 2019 as a large-scale face-to-face conference of the European Urology Association, EAU. This conference was conducted as a virtual satellite at the EAU conference in 2021. For a comparison of both formats see Table 1.

Overall, there were 13 digital satellites at this year's EAU. 6,402 delegates participated in one or more industry sessions in 2021. On average the industry sessions had 375 participants. The range was between 200 and 660 delegates per session. The average duration of the attendance of the industry session was around 37 minutes. The durations ranged from 28 minutes to 46 minutes.

The programmes of the 2019 face-to face satellite and the 2021 virtual satellite addressed the five principles of learning as follows. Principle #1: The role of prior knowledge: To activate participant's prior knowledge the opening of the satellites communicated clear Educational Objectives based on educational gaps identified on the topics presented. Principle #2 and #4: Context-dependent memory and knowledge organisation: To stimulate prior knowledge in the 2019 and 2021 satellite interactive polling questions addressing specific gaps identified were used to activate delegates. Based on the results on the polling questions new content was presented. Principle #3: Elaboration: learning is an active construction of meaning: the impact of new content in the daily clinical setting was discussed in both satellites by expert panel discussions and interactive questions from delegates. Principle #5: Situational interest: At the 2021 satellite interactive patient cases reflecting different clinical situations were used to activate delegates and to increase the stimulus for new data presented.

In 2019 delegates could send in their questions via a website to the co-chairs in 2021 we had the Q&A chat function open for the satellite to encourage delegates to ask questions or send in comments. See Appendix for a detailed breakdown of the programme with associated learning principles.

Although both conference formats were almost identical, there were also some little differences. For instance, the organisers changed the length of the satellite from 90 minutes in 2019 and 63 minutes in 2021. In both satellites the following elements of the learning principles were included:

1. Content dependent memory,
2. Context learning on a patient case,
3. Context learning of novel information
4. Active construction of meaning for each of the three specific clinical topics.

Presentations were shortened compared to the 2019 satellite and patient cases were used in the following clinical situations – low and high volume metastatic Hormon Sensitive Prostate Cancer and metastatic Castration Resistant Prostate Cancer to ensure activation of prior knowledge and situational interest for delegates.

Empirical Comparison of Learning Outcomes between a Face-to-face and Virtual Conference

Although it is difficult to objectively compare the outcomes of both conferences in terms of learning gains, we made an attempt to explore to what extent the overall objectives of both conferences were met. To that end, we compared the quantitative feedback obtained at the end of both events. The evaluation consisted of five items: (1) Learning Objectives met; (2) Impact on practice; (3) Educational quality of symposium compared to other educational interventions; (4) Content relevance; and (5) Scientific objectivity. The items were scored as percentage. For an overview of the results see Figure 2.

Overall, the findings suggest that the virtual conference was perceived as significantly more effective than the

Table 1. Basic data of the two symposia.

Criteria	2019	2021
Set up of satellite	Face-to face at the EAU congress with a possibility to join digitally	Completely virtual set up
Duration of satellite	1.5 hours	1 hour
Number of parallel sessions	4	1
Number of delegates	398 face-to-face/ 59 digital	598 digital live connections/ 305 on demand after the meeting over the website
Length of stay in the programme	No exact numbers – majority stayed to the end	42 minutes out of a 63 minutes program

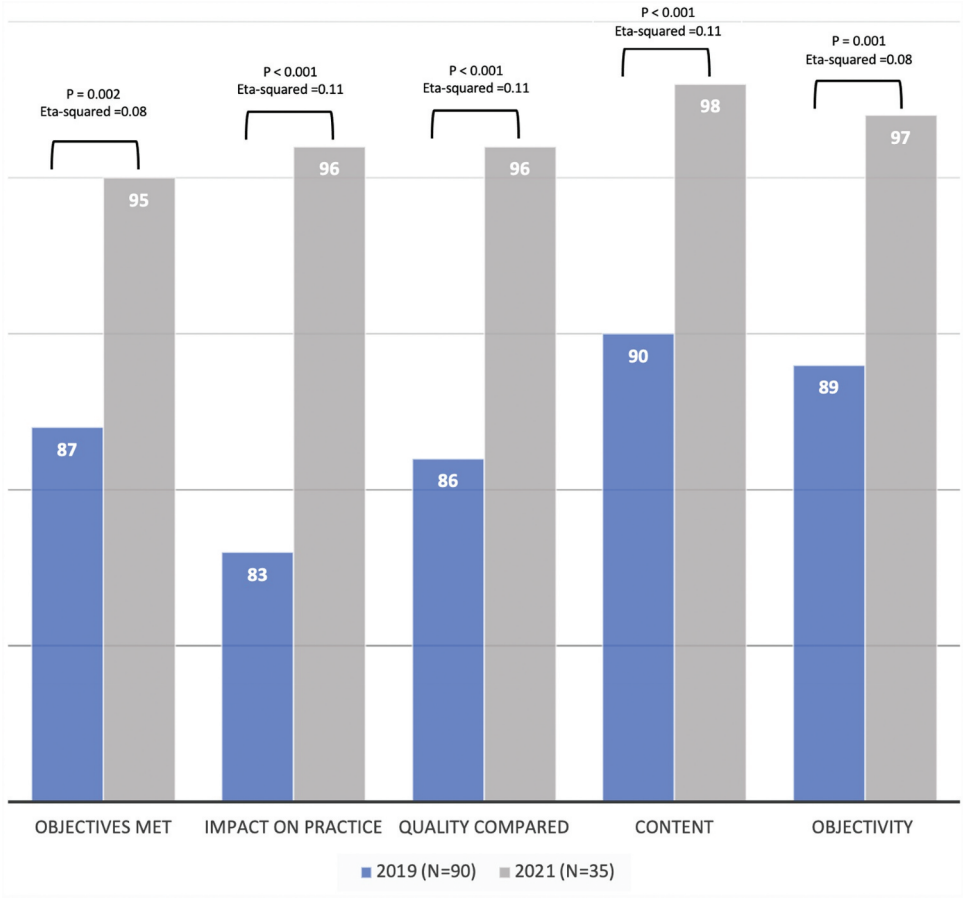

Figure 2. Comparison of programme evaluation scores (in percentage) between the 2019 face-to-face and the 2021 virtual learning event.

face-to-face conference on all five criteria. The effect sizes (eta-squared) were moderate, explaining about 10% of the variance. The overall Net Promotor Score (NPS) covering the question "Would you suggest this satellite to a colleague", in 2019, was 56 and in 2021 73. In addition, the feedback suggests that on the other items such as "Impact on practice" and "Educational Quality compared to other educational interventions", the score of the virtual event was significantly higher. The largest differences were observed on "Impact on Practice" (83% vs. 96%).

Conclusions and Future Research

Virtual conferences and other digital learning events are certainly here to stay on all levels of training; undergraduate, post graduate and continuing professional development. We have now reached a stage where the "technical literacy" seems to have increased significantly and many people are better prepared to either present behind a camera or organise an event/activity. Modern communication services/platforms have made all this rather smooth. What now remains is to add the "learning literacy" on top of this, i.e. apply an evidence-based design.

Our data suggest that the five evidence-based learning principles discussed in this paper apply *both* to face-to-face learning events and to digital learning and that digital learning is a valid alternative to face-to-face when comparing similar events run in 2019 and 2021. We consider this as an encouraging finding as we can also see that many digital events tend to attract more non-traditional attendees and have the potential to reach a much larger and geographically distributed audience.

We conclude by suggesting that active design of any digital event should combine "technical literacy" with "learning literacy". This will also enable us to better analyse and study the impact of learning, longitudinally and by comparison.

Apart from the formal curriculum at a digital meeting, what still needs to be better understood and analysed is the informal learning. Networking and peer-to-peer learning outside formal sessions are important features of face-to-face meetings but how or if this happens in formal digital learning events needs further systematic

attention. Chatbox content, frequency, communication patterns, etc., can easily be traced and this could lead to a number of studies both quantitative and qualitative.

Our present study has clear limitations in that it only analyses 2 events but with a deliberate approach to educational design using the principles as outlined above for future events, we can start to analyse, and not just describe digital learning events.

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Disclosure Statement

EHT is lead of external scientific relations EMEA at Janssen Cilag Pharma GmbH and stockholder of J&J. She was involved in the design of the satellites, preparation and final approval of the manuscript, but she was not involved in the interpretation of the data. JIR is adjunct Associate Professor at Erasmus University Medical Center, Institute for Medical Education Research Rotterdam (IMERR) and has prepared parts of the Introduction and the data analysis, NAP is lead of external scientific relations EMEA at Janssen Cilag Pharma GmbH and stockholder of J&J. She was involved in the design of the satellites, preparation and final approval of the manuscript, but she was not involved in the interpretation of the data. JN is the director of the Medical Case Centre at Karolinska Institutet, Sweden. He was involved in the design of this study, in the writing process and final approval of the manuscript.

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Appendix: Break down of scientific programmes and link to Learning Principles

2019 face-to-face satellite

Time	Action	Linked to learning Principles
17:45	Delegates enter the meeting room	
17:45–17:47	Opening video	
17:49–17:50	**Introduction** Welcome, disclaimer, programme and Learning Objectives, faculty and interactive polling system	Communicate the learning objective of the satellite
17:49–17:50	First interactive question	Engage with delegates through polling questions
17:50–18:00	**Is earlier treatment better? Lessons learned from mCRPC and mHSPC** –Presentation including 3 interactive polling questions (yes/no)	Context-dependent learning – novel information is linked to a specific context and also to context-dependent memory from the delegates' practice
18:00—18:05	Discussion with all faculty moderated by co-chairs	Active construction of meaning – discussion about new information
18:05	One-slide introduction nmCRPC	The next sections organise knowledge
18:05–18:15	**What is high-risk nmCRPC and how important is MFS?** –Including two interactive polling questions	Context-dependent learning – novel information is linked to a specific context and also to context-dependent memory from the delegates' practice
18:15–18:20	Discussion with all faculty moderated by co-chairs	Active construction of meaning – discussion about new information
18:20–18:40	**Why, when and how to treat nmCRPC? Taking a closer look at the results** –Presentation	Context-dependent learning – novel information is linked to a specific context
18:40–18:45	Discussion with all faculty moderated by co-chairs	
18:45–19:00	**Where do we go from here? Sequencing, combining, and personalising care** –Presentation	Context-dependent learning – novel information is linked to a specific context
19:00–19:12	Discussion and questions Overall discussion and time for audience questions moderated by co-chairs	Active construction of meaning – discussion about new information
19:12	Co-chair to prompt the audience to use the evaluation form through their devices and meeting close	
19:12–19:15	Final thoughts from experts	
19:15	Meeting adjourn	

2021 virtual satellite

12:45	**Event starts**	**Linked to learning principles**
	Welcome to the tumour board – co -chairs	
12:45–12:48	Opening of symposium: programme, learning objectives, faculty, evaluation form, interactivity	Communicate the learning objective of the satellite
	Putting it into practice: Set-up and opening	
12:48–12:52	Presentation on mHSPC disease heterogeneity – how can we individualise care – co-chair	This session is based on the ME gap analysis done earlier in the year – disease heterogeneity was a big educational gap identified – situational interest
12:53	Polling question: What proportion of patients with mHSPC do you think receive ADT alone?	Context-dependent memory either out of the delegates' practice or the data reported at ASCO – RWE trials from the US
12:54	Short discussion of polling result, mention RWE on ADT alone use – co-chairs and experts	Based on memory and polling outcome – faculty is discussing RWE data from ASCO
	High-volume mHSPC	
12:55	Short patient case: High-volume mHSPC	Context-dependent learning on a patient's case
12:56	Polling question: How would you treat this patient?	Interactive situational interest – trigger stimulus to test prior knowledge
12:56	Pose question: What is the evidence for treating this patient?	The next sections organise knowledge – triggered by patient case
12:57–13:00	Comment on how to treat the patient, incorporating new data on efficacy of treatments in high-volume mHSPC	Context-dependent learning – novel information is linked to a specific context
13:00	Pose question: QoL and general patient management considerations?	The next sections organise knowledge – triggered by patient case
13:01–13:04	QoL presentation	Context-dependent learning – novel information is linked to a specific context
13:04–13:06	Give perspective on QoL co-chairs and experts	Context-dependent learning – novel information is linked to a specific context – put into perspective by second faculty
13:06	Pose question: What if patient has visceral/liver metastases – does this change your approach?	The next sections organize knowledge – triggered by patient case
13:07–13:10	Give input to questions supported by slides – expert 2	Context-dependent learning – novel information is linked to a specific context
13:10–13:12	Roundtable discussion – co-chairs and experts	Active construction of meaning – discussion on new information
13:13	Give final thoughts on this section – co-chair	Active construction of meaning – summary of new information
	Low-volume mHSPC	
13:14	Short patient case: Low-volume mHSPC	Context-dependent learning on a patient's case
13:15	Audience polling question: how would you treat this patient?	Interactive situational interest – trigger stimulus to test prior knowledge
13:15	Pose question: is ADT enough in this setting?	The next sections organize knowledge – triggered by patient case
13:16–13:18	Comment on efficacy of treatment - presentation	Context-dependent learning – novel information is linked to a specific context
13:18	Audience polling question: Would you still consider RT to the prostate for this patient?	Interactive situational interest – trigger stimulus to test prior knowledge
13:19	Pose question: What about radiotherapy?	The next sections organize knowledge – triggered by patient case
13:19–13:22	Presentation on novel data	Context-dependent learning – novel information is linked to a specific context
13:23	Audience polling question: Your patient has low-volume disease by bone scan but PSMA PET shows 10 metastases. Does this change your treatment plan?	Interactive situational interest – trigger stimulus to test prior knowledge
13:24	Pose question: What are your thoughts?	The next sections organise knowledge – triggered by patient case
13:24–13:26	Roundtable discussion including guidelines – co-chairs and experts	Active construction of meaning – discussion on new information
13:26	Pose question: What about bone health?	The next sections organize knowledge - triggered by patient case
13:27–13:28	Bone health presentation	Context-dependent learning – novel information is linked to a specific context
13:29	Give final thoughts on this section -co-chair	Active construction of meaning – summary of new information
	mHSPC progressing into mCRPC	
13:30	Short patient case: mHSPC into mCRPC	Context-dependent learning on a patient's case
13:31	Audience polling question: How would you treat this patient?	Interactive situational interest – trigger stimulus to test prior knowledge
13:31	Pose question: How realistic is this scenario and how would you treat this patient considering previous treatments?	The next sections organise knowledge – triggered by patient case
13:32–13:34	Presentation on mCRPC treatments	Context-dependent learning – novel information is linked to a specific context
13:34–13:36	Roundtable discussion – co-chairs and experts	Active construction of meaning – discussion on new information
13:36	Pose question: What is the evidence on treatment sequencing in mCRPC?	The next sections organise knowledge – triggered by patient's case
13:36–13:38	Presentation on possible therapies	Context-dependent learning – novel information is linked to a specific context
13:38	Pose question: What about genetic testing and family history?	The next sections organise knowledge – triggered by patient's case and a new question
13:39–13:41	Presentation Genetic testing	Context-dependent learning – novel information is linked to a specific context
13:42	Give final thoughts on this section – co-chair	Active construction of meaning – summary of new information
	Wrap-up	
13:43–13:45	Ask each faculty member for their 10-second practical tip/lesson learned co-chairs and experts	Active construction of meaning – summary of new information
13:45	Close the meeting and remind audience of evaluation form	
13:45	**End of event**	