

## A new experience

*Live interactive planetarium shows online*

### Author(s)

Holt, Joanna; Hanse, Joris

### Publication date

2021

### Document Version

Final published version

### Published in

Planetarian

[Link to publication](#)

### Citation for published version (APA):

Holt, J., & Hanse, J. (2021). A new experience: Live interactive planetarium shows online. *Planetarian*, 50(1), 20-24.



### General rights

It is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), other than for strictly personal, individual use, unless the work is under an open content license (like Creative Commons).

### Disclaimer/Complaints regulations

If you believe that digital publication of certain material infringes any of your rights or (privacy) interests, please let the Library know, stating your reasons. In case of a legitimate complaint, the Library will make the material inaccessible and/or remove it from the website. Please contact the library: <https://www.amsterdamuas.com/library/contact/questions>, or send a letter to: University Library (Library of the University of Amsterdam and Amsterdam University of Applied Sciences), Secretariat, Singel 425, 1012 WP Amsterdam, The Netherlands. You will be contacted as soon as possible.

# A NEW EXPERIENCE:

## Live interactive planetarium shows online

By Dr. Joanna Holt & Joris Hanse



The NOVA flat-screen planetarium during testing at a primary school.

### ABSTRACT

NOVA coordinates a group of three inflatable mobile planetariums which visit around 200 primary and secondary schools per year (~30,000 students/year). After an initial stop in activities (March-June 2020) due to the COVID-19 crisis, NOVA restarted school visits in July 2020 using a high quality flat-screen. Since the start of the second peak of the COVID-19 pandemic in October 2020, the decision was made to suspend visits to secondary schools until at least the end of 2020. In late October and early November NOVA has performed extensive testing with a variety of online tools to continue to reach out to schools during the second wave of the pandemic in the Netherlands. In this article we describe the different platforms, discuss the technical considerations and report on the experiences with the first schools.

### BACKGROUND

The Netherlands Research School for Astronomy (NOVA) operates three mobile planetariums running Evans & Sutherland Digistar 6 software with a customised dashboard. The NOVA mobile planetariums visit around 200 schools per year (primary & secondary), reaching approximately 30,000 students and 1000 teachers annually. The planetarium shows are led by an expert, typically a later-years bachelor or master student in astronomy and are highly interactive. There is no set programme and after a short introduction, the show is led by the interests and questions of the students.

In August 2020, we reported the efforts of the NOVA team to try to continue operations during the COVID-19 period. The NOVA approach included modifications to the software to enable the images to be projected in 2D onto a high quality flat-screen (see Holt, 2020 for details). Shows have also been given in classrooms connecting the planetarium laptop to a digital white board.

Whilst the immersive experience and the three-dimensional aspects of the dome are lost, the highly interactive nature of the shows is retained. In our previous article we reported that the initial feedback from test schools is very positive. We have continued to receive positive feedback for the flat-screen approach from both teachers and presenters. The main advantages of working with the flat-screen can be summarized as follows:

- **The presenter can see the whole class which improves interaction.**

In the dome, some students sit behind the presenter. Presenters have reported an increase in contact with students when working with the flat-screen and that it is easier to ensure all students get a chance to ask questions.

- **The students are in general more focussed and less distracted by the dome.**

The dome environment is not only visually impressive, there are also interesting sound effects (e.g. specific sound reflections) which can distract some students from the content of the lesson. This is not the case with the flat-screen.

- **The image quality is better with the same technical setup.**

NOVA uses the same powerful projector (6500L) with a standard lens and the flat-screen projection area is just 1.6m x 1m. This results in a sharper and brighter image which makes some details easier to see.

### The current situation in the Netherlands

Despite the success of the flat-screen model, The Netherlands unfortunately entered a second wave of increased COVID-19 infections in October 2020. From October there has been a partial lockdown in place but schools remained open. At the time of writing (late-December 2020), the Netherlands entered a full lockdown which

will continue until at least late January 2021 including the closure of schools. It is expected that even after the lockdown ends, the risk level will not immediately return to risk levels low enough to safely visit all schools.

In early October 2020, despite schools still being open, for safety reasons, NOVA made the difficult decision to suspend all visits to secondary schools (12-18 years old) until at least the end of January 2021. NOVA has also produced a COVID-19 plan linked to the Dutch government's own risk-level system and on-site visits to secondary schools will only recommence in the lowest risk levels. The government advice in The Netherlands (since 1<sup>st</sup> July 2020) is that young children play an insignificant role in the spreading of COVID-19 and as such, children under 13 years old are exempt from all COVID-19 restrictions. For this reason, on-site visits to primary schools continue in all risk levels with the only exception being a full lockdown when primary schools are also closed.

In October 2020, NOVA began investigating the possibilities of virtual planetarium shows for secondary schools in The Netherlands. In this article we discuss further steps taken by NOVA in order to continue operations and reach secondary school students during the second (partial) lockdown in The Netherlands. We also report the technical details of our approach and the first experiences of schools.

### Virtual planetarium shows

Many institutions around the globe, including planetaria, have posted content online. This content is typically in the form of pre-recorded shows aired via channels such as youtube. Some organisations work with timed broadcasts during which planetarium staff are online to receive questions via a chat function. Whilst interesting content can be shared in this way, there is little or no interaction with the audience.

Audience participation is a crucial feature of the NOVA planetarium experience and this has driven the search for online solutions during the second wave of the pandemic.

### THE NOVA APPROACH

NOVA searched for the best software solution to share planetarium images and audio with schools. We compared four video calling/remote screen sharing applications, namely Zoom, Microsoft Teams, Google Meet and TeamViewer. We preselected these applications based on their ability to facilitate interaction with the teachers and students. As such, one-way streaming solutions, where interaction was difficult or impossible, were excluded.

We initially tested these applications focussing on the stability and quality of the shared video and audio. A second requirement was the ability to share images in full screen mode without any menus or control buttons native to the software visible. Finally, it is important that the selected applications are easy to use by both the school and the NOVA staff. During testing, we made sure the internet connection on both sides was good, to be able to make a fair comparison.

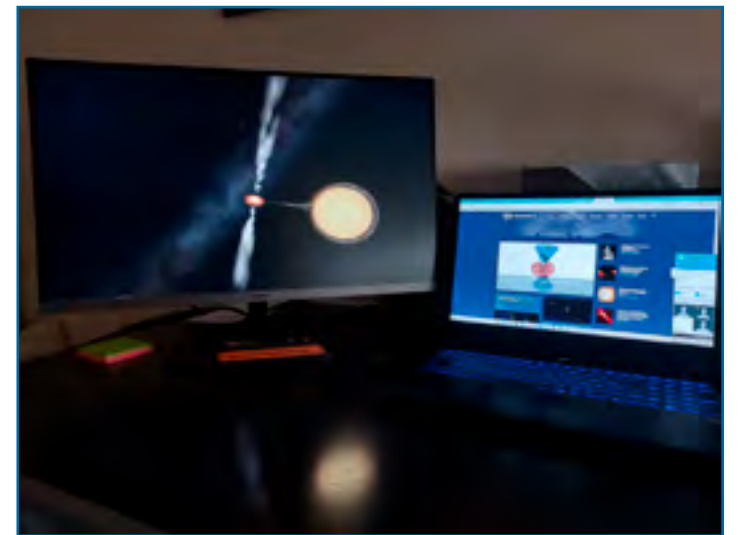


Figure 1: NOVA planetarium online test as viewed by an observer/the receiver. **Left screen:** The Digistar 6 images received via the internet from the presenter using the TeamViewer software. The TeamViewer transmission panel is in full-screen mode – no menus or control buttons are visible. **Right screen:** In the bottom right-hand corner of the laptop screen, the TeamViewer control panel can be seen showing 3 connections (presenter, school, observer).

### Not all video calling programmes are made equal

We found that, under our test conditions, TeamViewer offered the best video and sound quality meaning that the shared HD video images move smoothly on the screen and there were the least amount of visual artefacts due to e.g. changes in image resolution via the video calling software. Figure 1 shows a test call with TeamViewer at the receiving end – this is what the school would see.

Microsoft Teams offered a similar video quality to TeamViewer. Zoom's video quality was notably less; there were more visual artefacts and stuttering, most likely caused by the compression of the video stream.

Using Google Meet, the transmitted video quality was significantly lower than with the other tested software. In addition, we were unable to remove all menus, control buttons and texts from the full screen view, a feature which is possible using the other three tools.

After testing the different software tools, we looked into the technical specifications of the various software packages to try to understand why the observed differences were so large. Our findings are presented in the Appendix. Note that it was extremely difficult to find information on the system requirements and data usage of TeamViewer and in our free version, the connection information menu was not available.

We found that Google Meet operates at a lower resolution than the other three software packages and this is consistent with our observations. The only significant differences between Microsoft Teams, Zoom and what we believe to be correct for TeamViewer is:

- Frame rate – later versions of TeamViewer can achieve 60 fps compared to 30 fps for the other three;
- Required bandwidth – Teams and TeamViewer can



	VIDEO/AUDIO QUALITY	FULL SCREEN W/O CLUTTER	STANDALONE OR BROWSER VERSION	COST
<b>Zoom</b>	Good	yes	yes (browser)	free (or institutional subscription)
<b>Teams</b>	Excellent	yes	yes (browser)	free (or institutional subscription)
<b>Meet</b>	Good	no	yes (browser)	free
<b>TeamViewer</b>	Best quality	yes	yes (standalone) application	Free version has time limits, otherwise 360 euro/year in The Netherlands

**Table 1:** Comparison of the video calling software

work with full HD at just 1.5Mbps bandwidth whereas Zoom requires 2.5-3.0Mbps bandwidth for full HD;

- Teams and TeamViewer actively modify their settings (framerate, up/down bandwidth usage and resolution) during a call depending on availability and the programmes also check for process priority and where possible, take the highest priority.

It is important to note that, in addition to variations due to the technical specifications of the software packages themselves, the video quality may also depend on other factors such as the proximity of servers of the service used. It is therefore highly possible that tests performed in a different location may result in a different ranking of the programmes. We therefore recommend that thorough testing of at least the top three should be tried before making a decision on which software to use.

Before making a final choice, we also investigated other, less technical aspects of the various software packages namely whether a web or standalone application is available, whether a license is required and what this might cost and which software schools may already have installed on their systems. The first aspect is important because for a lot of schools in the Netherlands, IT services are organised centrally within a school and it is not possible for individual teachers to install custom software on their computers. For this reason we required the video call application to be available either through a browser or a standalone application. These aspects of the software are summarised in **Table 1**.

**The Choice between TeamViewer and Microsoft Teams**

Inspiring visuals are a key aspect of the planetarium shows and initially, we prioritised video quality and chose to use TeamViewer for our first live tests with schools. However, it became increasingly clear that TeamViewer had a few significant drawbacks:

Few schools were familiar with the software – in preparation for the planetarium shows, the schools needed to install the software and required technical assistance from NOVA on how to set up the video link.

Whilst there is a free version of TeamViewer available, this has time limits and for regular use, it is necessary to purchase an annual license. Given the uncertainty regarding how long it will be necessary to give the virtual shows and how many bookings are likely to be made, the licence is quite costly.

In contrast, all NOVA planetarium staff have access to professional licenses for Microsoft Teams. In addition, whilst it is possible to receive Microsoft Teams calls as a guest user, we found that many schools in the Netherlands also already have a professional Microsoft Teams license; the software is already installed on their computer systems and most teachers are familiar with the package.

With this in mind, NOVA has chosen to proceed with Microsoft Teams.

**Technical modifications required within Digistar 6**

The Digistar 6 planetarium software is, as default, designed to project onto a full dome. It was therefore necessary to make modifications within the software to enable projection onto a flat-screen and, later, to share video imagery via video calling software:

The latest Digistar 6 version was installed (6.20) which is necessary in order to change the projection mode. The projection mode was then changed from full dome projection to flat-screen projection.

The field of view, resolution and aspect ratio were modified in ‘floating dome view’.

The positioning of some of the content was changed, for example, the positioning of certain text labels. This was necessary as the image projected onto a flat-screen (or second screen for video calling) is a subset of the full dome image.

Modifications were made to the E&S Xbox controller script (which allows the viewing direction to be changed). NOVA presenters make extensive use of the Xbox controller to ‘fly around’ during shows. We added the ability to change the viewing direction using the direction pad on the controller making it possible to ‘look around’ at different parts of the sky. This was necessary due to the smaller field of view in flat-screen projection mode – at any given time, only part of the sky is visible on the screen.

Scripts for viewing video clips were adjusted. With the new settings (above), only a part of the full dome video was visible on the screen. We still wished to be able to use short videos and animations to explain certain topics and so it was necessary to adjust the video display parameters.

Overall, relatively minor adjustments to the software were necessary to convert the planetarium into flat-screen mode. During the first few tests, we identified and solved a few small bugs but in general, the transition was smooth.



**Figure 2:** Locations of the NOVA universities.

**Logistical considerations**

NOVA operates on a national level in the Netherlands. NOVA is the alliance of the four astronomical research institutes at Dutch Universities located in the cities of Amsterdam, Groningen, Leiden and Nijmegen (see Figure 2).

The network of NOVA mobile

planetariums also operates on a national level to visit schools across the country. All NOVA staff are affiliated to one of the four universities.

As discussed above in the technical sections, the virtual planetarium shows require a fast and stable internet connection. Most of the NOVA planetarium staff do not have access to professional quality internet connections at home. In addition, NOVA only has a small number of laptops running the Digistar software, not enough for each staff member to work with a different laptop.

With this in mind, and to reduce travel movements as much as possible due to COVID-19, permission was sought from each of the NOVA institutes to host the virtual shows. The virtual planetarium shows are given from each of the four NOVA universities – the staff member needs only to travel to their closest institute. NOVA planetarium laptops have been distributed to the different institutes and technical tests have been performed at each location.

**The experience of the NOVA mobile planetarium staff**

Four NOVA mobile planetarium staff have attended various test sessions (both internal NOVA test sessions and tests with two separate secondary schools) of the virtual planetarium and virtual shows have so far been given by two presenters. Earlier this year, all staff had reservations about whether the virtual shows would work, particularly with respect to the quality of the video link and whether it would be possible to have any interaction with the school students. This, combined with the relatively quick reopening of schools in the summer of 2020 in The Netherlands, was the reason to focus on the flat-screen solution.

All NOVA staff are impressed with the quality of the video links. Distortions in the images and/or non-smooth movements are few and far between.

The presenters have found that it is necessary to pay specific attention to interaction through, for example, the inclusion of short pauses and specifically asking for

questions before continuing with the show. With this small change in presenting style, presenters feel that just as many questions are asked as in shows given on location. Specific quotes from NOVA planetarium staff include:

*‘I must admit I didn’t have very high expectations for the virtual planetarium, but I was really surprised with how well it worked. I now think it’s a really good alternative during the pandemic.’*

*‘It’s takes a bit of getting used to, talking to a computer screen and not seeing the students’ faces, but the number of questions I received showed just how interested and engaged they were.’*

In summary, whilst physical lessons will always be the operation mode of preference, NOVA staff felt that with the addition of a third operation mode (virtual planetarium shows), it is still possible to provide an inspiring educational experience to secondary school students during the highest risk times in the COVID-19 crisis.

**The experience of the first schools**

In addition to the internal evaluation of the virtual planetarium shows, NOVA asked for feedback from the first schools to experience the online shows. Quotes from the teachers include:

*‘We were really happy with the online presentation. All of the teachers were very satisfied with the shows.’*

*‘Whilst it would have been wonderful to have a visit with the dome as usual, that’s not possible right now. We’re just so pleased that NOVA is still operating, and that this year’s students won’t miss out on this experience completely.’*

Despite this very positive feedback from a small number of schools, the majority of secondary schools with which we have had contact are significantly less interested in the virtual planetarium than in the flat-screen solution, even though NOVA offers this option at a significantly reduced price (40% discount). Whilst they can see the benefits of the flat-screen, especially when the images are projected on to a much larger screen at the school, the loss of face-to-face interaction with the speaker is for many schools a step too far. However, a small number of schools are very positive about the virtual shows and have made bookings knowing that the shows would be given virtually.

The feedback is in line with the driving educational principles behind the NOVA planetarium – live, interactive lessons in an immersive setting allowing for tailored content and the stimulation of ‘self discovery’ of astronomy concepts by the students. With this in mind, NOVA will only offer the virtual planetarium shows when all other operation modes are not possible for safety reasons.

**NOVA mobile planetarium bookings in the COVID-19 period**

As reported in our previous article (Holt, 2020), all NOVA mobile planetarium shows were cancelled for the period March-June 2020 inclusive. Schools were quickly



informed of the new flat-screen version of the planetarium which was available from July 2020 via email, the NOVA website and the annual flyer distributed to secondary schools in The Netherlands in September 2020.

The NOVA flat-screen planetarium has been enthusiastically received. Between August and December 2020, the effective bookings<sup>1</sup> were at approximately a third of the usual level pre-COVID-19. Bookings for the period January-April 2021 are currently at two-thirds of pre-COVID-19 levels. From the feedback from schools, we understand that the delay on reaching the level for January-April is due to the time lag for teachers and schools receiving the information that the NOVA planetarium is still operating during the crisis.

We also see a marked shift in the type of bookings we are receiving. Pre-corona, the majority of bookings were for secondary schools (80%) with just 4% of visits being to primary schools (the remaining bookings were for events). We now see in different periods between 20 and 60 percent of visits to primary schools. This is partly due to the current stop on physical visits to secondary schools – as discussed above, the interest in the virtual planetarium is much more varied than for the flat-screen.

<sup>1</sup>Number of bookings corrected for eventual cancellations.

**CONCLUSIONS**

Whilst the default operational mode of the NOVA mobile planetarium will continue to be the use of the inflatable dome, during the COVID-19 crisis, the flat-screen projection mode and the virtual planetarium provide flexible and safe options for schools, allowing NOVA to continue to reach primary and secondary school students across the Netherlands during this challenging time. Schools across the country are particularly enthusiastic about the flat-screen version of the planetarium whilst the response to the virtual planetarium shows are mixed. The majority of the technical work was required for the use of a flat-screen – very few extra modifications were implemented to create virtual shows after testing of the video calling software. With this in mind, we feel it is still worth the effort to provide this third option to schools. Whilst the majority of secondary schools are less interested in the virtual experience, some schools still consider this to be a good solution.

**REFERENCES**

Holt, J., The NOVA planetarium in the COVID-19 era, *Planetarian*, Vol 49, No 4, December 2020. Also distributed via the International Planetarium Society (IPS) website: <https://www.ips-planetarium.org/page/portableresources>

**Appendix – Summary of technical specifications of the video calling software tested**

	ZOOM	MICROSOFT TEAMS	GOOGLE MEET	TEAMVIEWER (PILOT)
<b>BANDWIDTH SCREEN SHARING</b>	Full HD 1080p video: Inbound: >2.5Mbps Outbound: >3.0Mbps	Full HD 1080p@30fps peer-to-peer: >1.5Mbps	Full HD 1080p bandwidth average per participant: Inbound: 1.8Mbps (ideal 2.6) Outbound 3.2Mbps	Full HD 1080p 1.5Mbps
<b>BROWSER</b>	Most but IE not fully supported	Most	Most	Standalone app
<b>RAM - RECOMMENDED</b>	4GB	4GB	8GB (can work with 4GB with few other concurrent browser functions)	
<b>PROCESSOR - MIN</b>	SC 1GHz+	2core+ 1.6GHz+	Quad core 6th Gen Intel i5 or equivalent	
<b>PROCESSOR - REC</b>	DC 2GHz+ (i3/i5/i7/ AMD equivalent)	Quad core for video/screen share res and frame rate	Quad core 6th Gen Intel i5 or equivalent	
<b>RESOLUTION</b>	Up to Full HD 1080p	Up to Full HD 1080p	Default is 720p (2.6Mbps+) otherwise downgraded to: 480p (1.5Mbps) 360p (1.0Mbps) 240p (0.5Mbps)	Up to Full HD 1080p
<b>FRAME RATE</b>	Up to 30fps (online search reveals it's often much less)	Up to 30fps but Teams modifies this depending on the bandwidth available – teams has high priority	Highest quality: 30fps	Max 60 fps
<b>NOTES</b>		Where bandwidth isn't limited teams optimizes media quality including up to 1080 p video res and up to 30fps for video and 15fps for content and high-fidelity audio	Meet is affected by how many other browser tabs are open at the same time as the meet session.	TeamViewer actively optimises up/down  Standalone programme

