

**Research Article**

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# The Effects of Structured Online Preparation for Medical Students Assisting at Surgery

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## Abstract

**Purpose:** The feeling of unpreparedness by medical students hinders learning in the operating room. The effects of an online structured video-based platform (Incision Academy) were analyzed during surgical clerkship.

**Methods:** In a prospective longitudinal study, medical students in their surgical clerkship were approached for participation. Self-reported comprehensibility, usefulness, satisfaction and feeling of preparedness with the video-based platform (7-point Likert scale) were compared between the start of the 3-week preparatory course (T0) and before (T1) and after (T2) the 8-week clerkship.

**Results:** The comprehensibility, usefulness and satisfaction were all rated an average of 6.00 [5.00 – 6.00]. The feeling of preparedness significantly increased between T0 and T1 ( $p < 0.001$ ), and between T1 and T2 ( $p < 0.001$ ). At T2, the feeling of preparedness was an average of 5.50 [5.00 – 6.00].

**Conclusions:** An online structured surgical education video-based platform which was found to be comprehensible, useful and highly satisfying, can contribute to the feeling of preparedness by medical students for participating in a surgical procedure.

**Keywords:** Incision academy; Surgical clerkship; Online learning platform; Medical education.

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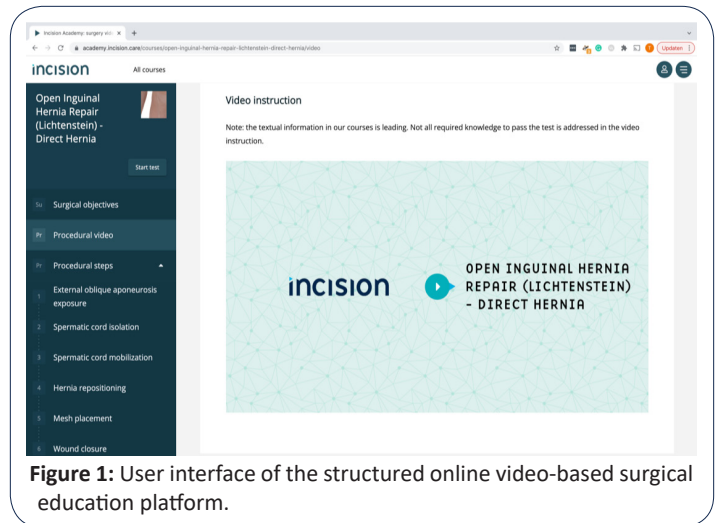
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## Introduction

For most medical students, surgical clerkship is the first time they set foot into an operating room (OR). Medical students recognize 'increased knowledge of surgical procedures and anatomy' as relevant learning outcomes of the surgical clerkship [1]. This clerkship can be conducted in general teaching and university hospitals with a different profile of the type of surgical procedures. The feeling of unpreparedness was reported as one of the main barriers to fully profit from participating in surgeries in the OR [1]. Currently, medical students have – besides traditional text and anatomy books – the availability of vast online resources, such as videos, podcasts, and social media to prepare themselves [2]. Though medical students report textbooks possessing a high educational quality [3], they increasingly use online video demonstrations, for example YouTube, to learn about a surgical procedure and anatomy [4,5]. Studies have shown the benefit of video-based learning to prepare for a surgical procedure in comparison to textbooks [6-8], however, the learning yield of internet videos varies. The educational quality of most online videos is doubtful [9]. Many videos miss a proper explanation of the surgical steps, which is deemed relevant to 'master' the whole procedure. Also, many internet videos show rare cases ('How I do it') or new and complex surgical techniques, which are less appropriate for medical students as learning and preparing tool. Altogether, it can be challenging for novices to choose the appropriate videos and structure their learning on short notice since schedules of the operations are often available the day before the actual surgery.

An online video-based surgical education platform was established (Incision Academy, Incision Group, Amsterdam, The Netherlands, [www.incision.care](http://www.incision.care)) including a wide range of surgical videos which making and editing was supervised by external expert surgeons, anatomists and surgical educators. Over 450 video courses can be accessed on this online video-based platform with uniform navigation buttons. Courses are on surgical skills, procedural courses, devices, anatomy, and basic knowledge. Each procedural course includes a step-by-step video demonstration and a detailed textual description of the surgical procedure [10], and supporting chapters regarding the surgical anatomy, surgical objectives, pre-operative measures such as instrument selection and positioning of the patient, postoperative complications, and knowledge tests (Figure 1). All courses are structured similarly in order to reduce to the extraneous cognitive load [11]. A procedural course takes on average 30 to 45 minutes to finish.

The hypothesis was that medical students found the online platform in which each course is structured similarly and each procedure within a course is explained in a step-by-step manner comprehensible and useful. This would result in more satisfaction with the use of the platform and ultimately increasing the feeling of preparedness for their clinical tasks. A longitudinal prospective study was designed in which an online video-based surgical education platform was introduced to medical students and the comprehensibility, usefulness, and satisfaction, as the feeling of preparedness were assessed.



**Figure 1:** User interface of the structured online video-based surgical education platform.

## Methods

### Participants, setting and design

Each medical school in the Netherlands consists of a three-year bachelor and a three-year master curriculum [12,13]. The master curriculum entails clerkships in different specialties in a fixed order. End fourth-year medical students of the Radboud University Medical Center, Nijmegen, The Netherlands starting with their 'surgical period' were approached for participation in the study. Written consent was obtained. Formal approval was waived for this type of study by the institutional board review according to Dutch law. The surgical period consists of twelve weeks, including three weeks of a preparatory course at the university campus, eight weeks of clerkship (in the academic hospital or one of six affiliated teaching hospitals), and one week of reflection and professional development activities. The three-week preparatory course is characterized by self-directed and blended learning and contains flipped classrooms, simulation training of basic surgical (laparoscopic) skills, and surgery-oriented conversation training with volunteer patients (spot-diagnosis anamnesis, comfort talk, bringing bad news).

In this study, a recently introduced online structured video-based surgical education platform (Incision Academy) was assessed for use and learning yield. At the start of a surgical period, a presentation was given in which the students were informed about the platform, the educational background of the platform, how to use the platform and were then approached for participation in this study. Each student was provided with personal access credentials to this online platform. During the surgical period, the platform was an adjunct to the curriculum for the students. Its use was entirely voluntary and not formally incorporated into the preparatory course or in the surgical clerkship.

### Surveys

Online surveys were sent at the end of the first week of the preparatory course (T0), at the start of the eight-weeks clerkship (T1) and at the end of the clerkship (T2). The questions in the survey regarded the use, comprehensibility (2 statements), usefulness (4 statements), satisfaction (7 statements), and feeling of preparedness (6 statements). The statements regarding comprehensibility were concerning the contents and language used on the platform. Each statement was rated on a 7-point Likert scale

ranging from 0 “Definitely not” to 7 “Yes definitely”, with 4 being neutral [14]. The participants were de-identified and were given research ID’s. Only the head investigators had access to this data. Appendix A shows the surveys at T0, T1, and T2. Data about user activity (number of videos play, tests and courses completed) until (T1) and (T2) were exported from the website.

**Appendix A:** Surveys during preparation weeks (T0), start of clerkship (T1) and end of clerkship (T2).

Use	T0	T1	T2
How much time did you spend on the Incision Academy?	X	X	X
<b>Comprehensibility</b>			
The contents were comprehensive		X	X
The language (foreign words and technical terms) was comprehensible		X	X
<b>Usefulness</b>			
The Incision Academy was helpful for my understanding of surgical procedures		X	X
The Incision Academy was helpful for my understanding of basic surgical skills		X	X
The Incision Academy was helpful for my understanding of surgical anatomy		X	X
My understanding about procedures was helped by the step-by-step approach		X	X
<b>Satisfaction</b>			
The content of the Incision Academy is of high quality			X
I would use the Incision Academy to prepare myself for O.R. in future			X
The usage of the Incision Academy was fun			X
I can apply the content of the Incision Academy in my practice			X
Investing time in the Incision Academy was useful			X
I derive personal use from the Incision Academy			X
I have the impression that my knowledge has expanded on a long-term basis by using the Incision Academy			X
<b>Feeling of preparedness</b>			
I feel I have sufficient sources to prepare myself for procedures	X	X	X
I feel I have sufficient knowledge about surgical procedures	X	X	X
I feel I have sufficient knowledge about objectives of surgical procedures	X	X	X
I feel I have sufficient knowledge about complications after surgery	X	X	X
I feel I have sufficient surgical anatomical knowledge	X	X	X
I feel I have sufficient knowledge about basic surgical skills (e.g. knots, sutures, instruments)	X	X	X

**Statistical analysis**

The internal consistency of the surveys was determined using Cronbach’s  $\alpha$ , in which 0.70 to 0.79 indicated a fair, 0.80 to 0.89 a good, and 0.90 to 0.99 an excellent internal consistency. Normality was tested using the Shapiro-Wilk test. The non-normal distributed data were described by the median and range or interquartile range (IQR). In this study, the Wilcoxon signed-rank test was used due to skewed data to compare the outcome measures between T0 and T1 and between T1 and T2. The statements within the categories of the feeling of preparedness, comprehensibility, usefulness, and satisfaction were rated on a 7-point Likert scale. One-sample Wilcoxon signed-rank test was used to compare the median of these categories to the neutral value of 4 on the Likert scale. A  $p$ -value of less than .05 was considered statistically significant. All statistical analyses were done with SPSS (IBM Corp. Released 2016. IBM SPSS Statistics for Windows, Version 24.0. Armonk, NY: IBM Corp.).

**Results**

The survey was sent to 187 students and completed by 165 students during the preparation course (88%), by 113 students at the start of the clerkship (60%), and by 108 students at the end of the clerkship (58%; Table 1). In the end, 79 students completed all three surveys (42%), 53 students two surveys (28.3%), 43 students one survey (23%), and 12 students no surveys (6.4%). The average age at the beginning of the surgical period was 22 years (range 21 – 36). The online video-based courses were mostly used during the clerkship (Table 1). The median number of videos watched was 0 [0 – 2] during the preparatory course and 18 [10 – 30] during the clerkship ( $Z = -11.51, p <.001$ ). The self-reported activity on the Academy platform was a median of 1 hour [0.5 – 2] during the preparatory course and a median of 5 hours [0 – 10] during the clerkship ( $Z = -5.72, p <.001$ ).

**Table 1:** Use of platform.

	During preparatory course median [IQR]	During clerkship median [IQR]	p - value <sup>^</sup>
Objective measurements			
Videos played	0 [0 – 2]	18 [10 – 30]	<.001*
Courses completed	0 [0 – 0]	1 [0 – 3]	<.001*
Tests made	0 [0 – 0]	0 [0 – 2]	<.001*
Subjective measurement			
Self-reported time spent on Incision Academy (in hours)	1 [0.5 – 2]	5 [0 – 10]	<.001*

IQR interquartile range [Q1 – Q3]; <sup>^</sup> Analyzed using Wilcoxon signed-rank test; \* Statistically significant  $p < .05$

As shown in (Table 2), the category ‘comprehensibility’ had an excellent and good internal consistency at T1 and T2, respectively (Cronbach  $\alpha = .903$  and Cronbach  $\alpha = .817$ , respectively). At the beginning and end of the clerkship, students rated the structured online learning positively on this topic (median 5.00 [4.00 – 6.00],  $Z = 6.36$ ,  $p < .001$  and median 6.00 [5.00 – 6.00],  $Z = 8.68$ ,  $p < .001$ , respectively). From T1 to T2, the comprehensibility increased significantly,  $p < .001$ . Usefulness had an excellent and fair internal consistency at T1 and T2, respectively (Cronbach  $\alpha = .928$  and Cronbach  $\alpha = .734$ , respectively). The usefulness was rated at both moments to be positive. This rating increased significantly over T1 and T2,  $p < .001$ . The overall satisfaction measured at T2 was very positive, with a median of 6.00 [5.00 – 6.00],  $Z = 8.33$ ,  $p < .001$ .

The internal consistencies of the category ‘feeling of preparedness’ during T0, T1, and T2 were fair to good (Cronbach  $\alpha = .831$ , Cronbach  $\alpha = .820$  and Cronbach  $\alpha = .767$ , respectively; Table 3). The feeling of preparedness was lower than the neutral value at the beginning of the preparatory course with a median score of 3.00 [2.38 – 4.00],  $Z = -.806$ ,  $p < .001$ . At T1 and T2, the feeling of preparedness was above the neutral value, median 4.00 [3.50 – 5.00],  $Z = 2.10$ ,  $p = .036$ , and median 5.50 [5.00 – 6.00],  $Z = 8.88$ ,  $p < .001$ . As shown in Figure 2, the feeling of preparedness significantly increased between T0 and T1 ( $p < .001$ ), and between T1 and T2 ( $p < .001$ ). In further analyses, comparing students that watched less videos than the median to students that watched

**Table 2:** The comprehensibility and usefulness of the online platform during the clerkship.

	Start clerkship (T1)	End clerkship (T2)
<b>Comprehensibility</b>		
Cronbach's $\alpha$	.903	.817
Median [IQR]	5.00 [4.00 – 6.00]	6.00 [5.00 – 6.00]
p-value <sup>^</sup>	<.001*	<.001*
<b>Usefulness</b>		
Cronbach's $\alpha$	.928	.734
Median [IQR]	5.00 [4.00 – 6.00]	6.00 [5.00 – 6.00]
p-value <sup>^</sup>	<.001*	<.001*

Statements rated on 7-point Likert scale; 1=strongly disagree to 7=strongly agree.

IQR interquartile range [Q1 – Q3]; <sup>^</sup> Analyzed using one-sample Wilcoxon signed ranked test, compared to neutral value of 4; \* Statistically significant  $p < 0.05$ .

more than the median, and analyses comparing students that watched less than 10 (below Q1) to more than 30 videos (above Q3) no significant differences were found concerning the feeling of preparedness. Nor were any correlations found between the number of videos watched and the feeling of preparedness.

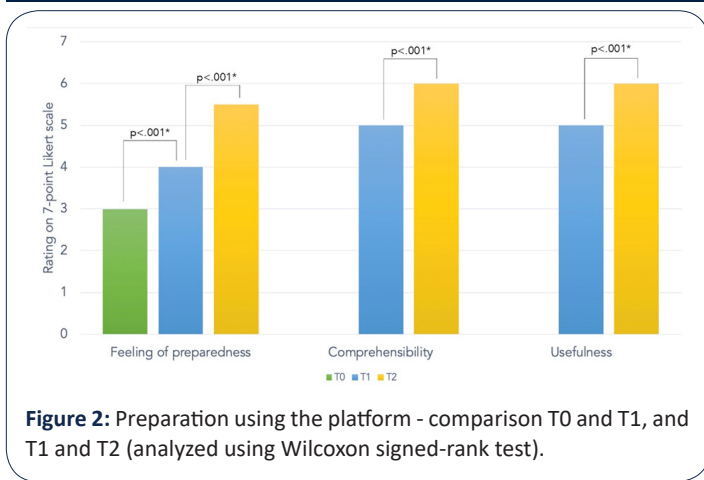
**Table 3:** The feeling of preparedness.

	Preparation weeks (T0)	Start clerkship (T1)	End clerkship (T2)
<b>Feeling of preparedness</b>			
Cronbach's $\alpha$	.831	.820	.767
Median [IQR]	3.00 [2.38 – 4.00]	4.00 [3.50 – 5.00]	5.50 [5.00 – 6.00]
p-value <sup>^</sup>	<.001*	.036*	<.001*

Statements rated on 7-point Likert scale; 1=strongly disagree to 7=strongly agree

IQR interquartile range [Q1 – Q3]; <sup>^</sup> Analyzed using one-sample Wilcoxon signed ranked test, compared to neutral value of 4; \* Statistically significant  $p < 0.05$





**Figure 2:** Preparation using the platform - comparison T0 and T1, and T1 and T2 (analyzed using Wilcoxon signed-rank test).

## Discussion

Initial qualitative evaluation of a structured online video-based surgical education platform shows that students found the platform comprehensible, useful and were satisfied with its use. This type of structured preparation was most utilised during the clerkship. The students felt increasingly better prepared during the clerkship. These findings hold promise for including this platform as just in time teaching and learning strategy in surgical clerkships in hospitals with a different clinical profile. The use of online – mostly YouTube – videos at the discretion of students has been reported before, and we share with most authors the concern regarding the quality and learning yield of these ‘educational’ sources for a surgical clerkship [4,5,15-17]. In general, online surgical videos are unstructured and do not aim at knowledge and skill development [17]. YouTube videos are ranked by popularity and not by educational value, and the video content may even be misleading, showing protocol violations of surgical procedures [18]. A recent study confirmed the lack of quality and even drawback of laparoscopic cholecystectomy videos on YouTube as half of the videos showed hazardous surgical manoeuvres, and only one in ten videos demonstrated the ‘critical view of safety’ step [9]. The critical view of safety step is deemed essential for avoiding serious complications and is an indispensable step in the surgical procedure according to national and international guidelines on laparoscopic cholecystectomy and in detail presented in the Incision Academy film performed by an expert in this field [19-20]. A review of 68.000 ‘educational videos’ for basic criteria such as adequate neurovascular examination and employing traction during application of the cast regarding distal radius fracture immobilization revealed only 16 videos that met the basic criteria [21]. These reports underline the importance of helping students to find their way in the massive marketing of surgical videos on the internet and to put effort in supporting medical students with online videos of surgical procedures with high educational quality and controlled by the surgical community. The Incision academy is different in a way that all courses have the same structure and are based on international guidelines with well-known experts performing the surgery with attention to relevant details and variations.

In this study, students used the online video material mainly during the clerkship. Use during the preparatory course was also anticipated considering the introduction of the Incision Academy at the start of the preparatory course. During this preparatory

course, the students receive general information about surgery and not detailed knowledge of specific procedures. Apparently, students use this educational tool at the time they must prepare for the surgical procedure they are going to attend during the clerkship. This underlines the “just-in-time” learning strategy of students [22]. This learning strategy is logical since they work in hospitals that differ considerably in their surgical practice profile and daily scheduling of procedures. Online educational videos are appropriate just in time learning resources because they can deliver education to students when and where they need it. The just-in-time learning is also underlined by the fact the students watched the videos, and not completed the entire course of participated in the online available tests (Table 1).

Although the median number of online videos watched seems adequate, there was a considerable variation between students, and the median self-reported time spent was only 5 hours, with some students being not active at all. While the use of other sources of preparation was not assessed, speculated is that the learning yield of the online video-based surgical education platform would increase when the platform would be incorporated as an obligatory learning and teaching tool in the clerkship for students and teaching staff. Participants should be fully aware about the content of the platform as it contains surgical procedural knowledge, surgical anatomy, and surgical skills content. The values of using the structured online video-based platform in the preparatory course [23], particularly the surgical anatomy and skills parts, needs to be determined in future research. There seems to be a discrepancy in expectations between surgeons and medical students and what they consider as well prepared [24,25]. Surgeons expect general attributes in the operating room, such as arriving on time and showing interest, and do not expect broad and detailed surgical knowledge [25]. However, medical students found it distressing if they miss detailed information on surgical procedures and are unable to anticipate because they lack knowledge of the course of actions and events during an operation [24,25]. Using structured videos with texts describing the procedural steps of a surgical procedure and explaining the rationale behind the steps’ order seemed to fulfil the expectations of the students considering the increasing feeling of preparedness during the clerkship.

## Strengths and limitations

In the present before and after study, the voluntarily use of online videos as an educational tool by a large cohort of medical students in the surgical clerkship and the preceding preparatory course is investigated. The comprehensibility, usefulness and satisfaction of the platform was examined. The number of students who participated in the initial surveys was high, strengthening the results of the study. However, the decreasing number of participants taking part in the subsequent surveys might have overestimated the reported learning effects of the platform. It is possible that mostly students who were highly motivated for a surgical specialty or who preferred online learning continued to fill out the surveys. Although self-reported outcomes such as preparedness and confidence are considered relevant for assessing the impact of surgical educational methods, they may be over- and underestimated by students depending on contextual factors and personal traits [26].

One of the main barriers for medical students to fully profit from participating in surgeries in the OR was the feeling of unpreparedness [1]. In this study, the feeling of preparedness increased in time, however, the experience of students increased too. A randomized control design was considered for this study, providing more robust results. However, in this group of medical students the concern was about randomization bias due to the impossibility of blinding and the interactions between groups during the preparatory courses and clerkship. For that reason, a longitudinal study design was chosen. Seeing more procedures in the OR perhaps increased the feeling of preparedness of the students, the online structured video platform might accelerate this feeling as the students would be better prepared as to what to expect on the OR. In future research, a randomized control trial should be performed to determine if the feeling of preparedness was a contribution of Incision Academy. Acknowledging the difficulty of objectifying the effect of this educational intervention on the competency of medical students participating in the operating room, a future study will include audio- and video-recording of student activities in the operating room with and without using the Incision Academy platform for preparing the surgery.

### Implications for educational practice and future research

The initial learning yield of the voluntary use of the Incision Academy platform as an adjunct to other educational activities and tools in the surgical clerkship is encouraging. With increased use by medical students in and outside the Netherlands, the optimal package of videos needed to be prepared for successful participating in a surgical procedure can be defined and specified for each medical school. Efforts should be put in comparing online video-based learning with other educational means regarding efficacy, resources needed, time spent, and financial costs. Expected is that the learning yield of structured online video-based surgical education will increase when it becomes fully integrated into the surgical clerkship and also surgical teachers use it as a teaching tool. Due to the continuing growth in skills videos, surgical attitude, surgical anatomy and more structured videos of surgical procedures, also more complex operations, the platform becomes more attractive for medical students as residency and fellowship programs.

### Conclusions

A recently online structured surgical education video-based platform which was found to be comprehensible, useful and highly satisfying, can contribute to the feeling of preparedness by medical students for participating in a surgical procedure. These findings hold promise for including this platform as a just in time teaching and learning strategy in surgical clerkships.

### Declarations

**Conflict of interest:** Authors TW was employee of Incision Academy at the time of the study.

**Statements and declarations:** This research did not receive funding from agencies in the public, commercial, or not-for-profit sectors. In particular the Incision Academy had to access to the data of this study.

The datasets generated during and/or analyzed during the current study are available from the corresponding author on rea-

sonable request.

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