INCISION e-learning program as a useful teaching tool to enhance surgeons' knowledge and skills: An Indonesian multi-center cross-sectional pilot study [version 1; peer review: 1 approved with reservations]

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Abstract

Background: Media aids are one of the most important components in the teaching and learning process. This pilot study program was conducted in order to assess the effectiveness of the INCISION e-learning program as teaching media in the surgical teaching and learning process, and its ability to improve surgical skills and knowledge achievement.

Methods: One intervention group and one control group were involved in this study. The intervention group used the hysterectomy INCISION e-learning module, while the control group used conventional teaching approaches. The study was conducted with 14 resident surgeons in three universities in Indonesia: Universitas Indonesia, Universitas Airlangga, and Universitas Gajah Mada. The testing components used were a pre-test, post-test questionnaire (a modified Ritzman questionnaire) and direct observation of procedural skills in the operating room (OR). Data were analyzed descriptively using Mann-Whitney and Wilcoxon tests.

Results: Using a Mann-Whitney test, we found the differences between the average scores of the intervention group and the control
group to be statistically significant ($p=0.046$). A Wilcoxon test also revealed significant differences ($p=0.028$). The modified Ritzman questionnaire also revealed that the residents in the intervention group felt more confident in their surgical knowledge (82%), and made more efficient use of their time in the OR (81%).

**Conclusions:** These findings reveal a significant improvement in knowledge and skill achievement in residents that underwent training via the INCISION e-learning module, compared to residents taught via conventional teaching strategies.

**Keywords**
INCISION, e-learning, surgeon, skills, knowledge
Introduction
The use of multimedia as a learning tool is one of the best educational techniques as it is able to engage more than one sense simultaneously, generally the senses of sight and hearing. Multimedia programs provide a variety of different stimuli, including elements of text, speech, sound and music, graphics, animations and still pictures. In undergraduate and graduate medical training, the type of teaching media used depends on the institution as well as the individual teacher and the subject matter being taught.

Traditionally, medical teachers explain theories and demonstrate procedures, followed by practice by the trainees (“see one, do one”). There are four teaching approaches to surgical education including: standardized/simulated patients; procedure courses, videos, textbooks; web-based training; cadavers and live animals. Nowadays, technological development has influenced the ways in which learning and information presentation takes place, with a variety of technological tools now supplementing and partly replacing paper books. The INCISION e-learning module is a new learning and teaching approach, comprised of an online learning platform designed to transfer procedure-specific knowledge to surgeons, gynaecologists and residents. INCISION also provides some information on pre- and postoperative care; however the primary focus is on procedure and the relevant surgical anatomy.

In this pilot study, we sought to evaluate the effectiveness of the INCISION approach on the transfer of relevant surgical knowledge, as well as to assess the strengths and weaknesses of e-learning via INCISION from the point of view of the surgery resident.

Methodology
Study design
The INCISION pilot study program involved 14 surgeon residents specializing in obstetrics and gynecology (OBGYN). Inclusion criteria included residents in 3–6th semester who had never been trained for hysterectomies, while exclusion criteria included participants who were not willing to participate in this study or had incomplete filling of the questionnaire.

We divided residents into an intervention group and a control group by random number generation, consisting of 7 surgeon residents in each group. Recruitment of the participants was done by asking residents in 3–6th semester in person on July until August 2015 during the break after class at three universities: Universitas Indonesia, Universitas Airlangga, and Universitas Gajah Mada.

The intervention group used the hysterectomy INCISION e-learning module, while the control group used conventional teaching approaches. The distribution of participants is shown in Table 1.

This study was approved by the Ethics Committee of Faculty of Medicine, Universitas Indonesia, on July 6th 2015 (reference number: 564/UN2.F1/ETIK/2015). Permission was obtained to perform this study in all three sites. Written consent for participation was obtained from all study participants.

Time and location
This study was conducted between July and August 2015, in the medical facilities and hospitals of: Universitas Indonesia, Universitas Airlangga and Universitas Gajah Mada.

Testing instruments
Four evaluation methods were used. First, we included a pre-test with the purpose of evaluating the residents’ knowledge of procedures prior to training (Supplementary File 1). Second, a post-test was conducted after having received the course material (Supplementary File 1). Third, a Ritzman questionnaire was administered to evaluate the residents’ perception of the INCISION approach on the training material, and how it impacted their knowledge (Supplementary File 2). The Ritzman questionnaire was not taken by the control group, only the intervention group. Every question is rated on a score of 1 to 7, which when converted into a percent is able to be grouped as >80% = good, 50-79% = average, and <50% = bad.

Finally, residents performed the procedure under the supervision of a qualified trainer, which was not assessed.
In-depth interviews were also conducted with the intervention group for assessment value of INCISION e-learning. Residents were interviewed by the research team in the Obstetrics and Gynecology Department’s Meeting Room. The research team wrote notes during the interview only. The residents were asked about added value of using INCISION e-learning; weakness, difficulties or obstacles encountered during the study with INCISION e-learning; the difference between INCISION e-learning and conventional teaching; and whether the residents will recommend INCISION e-learning for their friends.

**Procedure**

Residents participating in the study were given a pre-test during the first week of the study period. This test served as an entry exam to gauge their incoming level of expertise with the particular procedure. Starting in the second week, the intervention group of residents commenced learning via the class with INCISION e-learning 2D module, while the control group of residents were taught via presentation methods.

On the third week, trainers and residents from the intervention group took the class with INCISION e-learning 3D module and discussed it together, while the control group watched the trainer and followed the operation of a patient. Finally, all residents conducted the post-test. The residents took the exam at least once during the week after the study period.

**Supplementary File 3** contains information about the conventional course.

**Data analysis**

Data were analyzed descriptively using SPSS 21 version statistical software, using Mann-Whitney and Wilcoxon tests for statistical analysis. We used a non-parametric test due to the small sample size. The Mann-Whitney test was used to examine the differences in knowledge based on the pre-test examination. The Wilcoxon signed-rank test was also used to evaluate the difference between courses, using data from a paired-sample design. We used the Wilcoxon test to determine whether there was a difference between the intervention group and the control group at the end of the pilot program, based on the administered post-test. A p value <0.05 was considered statistically significant.

**Results**

All subjects completed the study; no participants declined to be part of the study.

Figure 1a shows the score distribution of the pre- and post-tests in the control group. Five residents decreased their score and two showed an increase. However, in the intervention group, the majority of residents increased their score, as shown in Figure 1b.

We evaluated differences between the two groups’ average pre-test scores in order to determine whether there were any differences in knowledge and skill prior to intervention. Using a Mann-Whitney test, we demonstrated that the average value of the pre-test in the control group was not significantly different from that of the intervention group (p=0.561).

Further evaluation of the average post-test scores between the control and intervention groups was important to determine whether there were differences in knowledge and skill following intervention. Using a Mann-Whitney test, we found that the average score of the intervention group (67), was significantly greater than that of the control group (53). This difference was statistically significant (p=0.046).

We then compared the pre- and post-test results within each group. The average pre-test score in the control group was 52.71, while the average post-test score in the control group was 52.71. There was no difference between the pre- and post-test results in the control group. The average pre-test score in the intervention group was 50.14, while the average post-test score was 66.93. A Wilcoxon test revealed that this difference was significant (p=0.028).

Residents in the intervention group were satisfied with the training outcome, with an average Ritzman questionnaire score of 81% (Table 2). The highest score, 86%, was given for the
Table 2. Ritzman questionnaire analysis.

| Ritzman Questionnaire                          | Average Score/item |
|-----------------------------------------------|--------------------|
| **Training Outcome**                          |                    |
| Overall, I like the course                    | 82                 |
| The learning atmosphere was agreeable         | 78                 |
| The learning was fun                          | 73                 |
| I find the approach useful for my job         | 86                 |
| Investing time in the course was useful       | 82                 |
| I can apply the content of the course in my job | 88              |
| I derive personal use from the course         | 80                 |
| **Average**                                   | **81**             |
| **Comprehension**                             |                    |
| The contents were comprehensible              | 86                 |
| The language (foreign words and technical term) was comprehensible | 83 |
| I kept up thematically in the course.         | 82                 |
| The time was sufficient for the theme covered.| 80                 |
| **Average**                                   | **83**             |
| **Knowledge gain**                            |                    |
| I have the impression that my knowledge has expanded on a long-term basis | 82 |
| I will be able to remember the new themes well | 78 |
| I think that I will still be able to report what I learned some time after the course. | 71 |
| I will apply what I learned to my day-to-day work | 76 |
| I would recommend the INCISION approach to my colleagues | 80 |
| **Average**                                   | **77**             |
| **Media**                                     |                    |
| The 2D film were helpful for my understanding | 76 |
| The 3D films were helpful for my understanding | 90 |
| The online Academy was helpful for my understanding | 88 |
| The 3D film was suitable for presenting the contents | 94 |
| The 2D film was suitable for presenting the contents | 80 |
| The online Academy was suitable for presenting the contents | 80 |
| **Average**                                   | **84**             |
| **Customized additions:**                     |                    |
| **Training outcome**                          |                    |
| I feel more confident in my surgical knowledge after following the INCISION Approach | 82 |
| I feel I made more efficient use of my time in the OR after following the INCISION approach. | 81 |
| My understanding of the procedure was helped by the step-by-step approach. | 88 |
| I feel patient safety is increased due to the INCISION approach | 82 |
| **Average**                                   | **83**             |
| **Product Feedback**                          |                    |
| There needs to be more images / stills in the Academy. | 80 |
| There need to be more videos in the Academy  | 78                 |
| There need to be longer videos in the Academy | 84                 |
| **Average**                                   | **80**             |
statement that residents believe the content of INCISION is useful for their job. On average, residents felt that they appreciated the course (82%), that the learning atmosphere was encouraging (78%), that the learning was fun (73%), and that they obtained beneficial knowledge from the course (80%). The residents also felt that the INCISION e-learning was comprehensible (82%). The content and the language (foreign words and technical terms) was also found to be easy to comprehend (86 and 83%, respectively). They felt that they kept-up thematically with the course (82%), and that the time spent was sufficient for the theme covered (80%).

Additionally, residents in the intervention group felt that INCISION e-learning provides an adequate gain in knowledge (77%). They had the impression that their knowledge had expanded on a long-term basis (82%), that they would be able to remember the new themes well (78%), and that they think they will be able to sufficiently report what they had learned some time after the course (61%). They also expressed that they will apply what they learned to their day-to-day work (76%), and that they would recommend the INCISION approach to their colleagues (80%). Overall, the residents rated the INCISION media as good (84%). They preferred 3D film (90%) over 2D film (76%), for ease of understanding the content. With respect to content presentation, they also found 3D film (94%) to be more suitable than 2D film (80%). They felt that the online academy both aided understanding (88%), and was an acceptable medium for presenting the content (80%).

The residents also felt more confident in their surgical knowledge (82%), and made more efficient use of their time in the OR (81%) after following the INCISION approach. They thought that the understanding of the procedure was aided by the step-by-step approach (88%), and feel patient safety would be increased due to the INCISION approach (82%). Regarding product feedback, the residents thought that more images should be provided (80%), as well as more (78%) and longer (84%) video segments.

In the in depth-interview, most residents said that INCISION e-learning via its 3D videos was able to improve knowledge and skills. They said that the advantage of using INCISION e-learning was that it can be accessed anywhere and at anytime, but there were limitations to access the program, for example, when they be located in remote areas that don’t have internet access the program couldn’t be used. Finally, all residents in the intervention group said that they will recommend INCISION e-learning due to their positive learning experience to their colleagues.

Discussion
The results of this study correspond to our expected outcome regarding the INCISION e-learning paradigm. The initial knowledge and skills of residents in both the control and intervention groups were similar, whereas following INCISION e-learning training of residents in the intervention group, the knowledge outcome was significantly increased. We can therefore conclude that INCISION e-learning is able to increase residents’ knowledge compared to conventional learning.

The limitation of this study design was the small number of participants; however, this meant that we were able to complete this report with in-depth interviews of the residents in the intervention group, as shown in Table 3. They discussed the value of INCISION e-learning, including weaknesses, difficulties, and obstacles encountered during the study, as well as the difference between learning with or without the INCISION module. They also discussed whether they would recommend the program to others.

Most residents reported that INCISION e-learning was able to improve knowledge and skills via its use of 3D videos. Another reported advantage was that it can be accessed anywhere and at anytime. Reported weaknesses of the program was limitations to access should they be located in remote areas. Residents also reported that they will recommend INCISION e-learning to their colleagues due to their positive learning experience.

These results are consistent with previous studies that report the efficacy, and the satisfaction amongst users, of multimedia as learning tool for medical purposes, in particular for surgical learning[5,11].

Conclusion
These findings reveal that there were significant differences in knowledge and skill achievement between students who underwent training via the INCISION e-learning module and students who were trained via conventional teaching strategies. In addition, a questionnaire revealed that resident surgeons in the intervention group appreciated the use of INCISON e-learning.
| Student ID | University | What is added value of INCISION e-learning? | Will you recommend INCISION Academy online learning? | What is the weakness, difficulties or obstacles encountered during the study with INCISION Academy online learning? | Constraints/difficulties during the learning is in the phase of action with instructors from the Incision. The value is we can learn more easily, can understand, and facilitated the learning process for us. Yes, I would recommend this tutorial. |
|------------|------------|--------------------------------------------|-------------------------------------------------|-------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| R1         | Universitas Indonesia | The value of Incision is we could have access to learning materials anytime and anywhere. Yes, with Incision learning materials more easily understood because the real picture given by 3D program. | Yes, by recommending this incision. I hope my colleagues can get the added value of the program that also prioritizes education and facilitate the learning process for us. | Constraints/difficulties during the learning is in the phase of action with instructors from the Incision. The value is we can learn more easily, can understand, and facilitated the learning process for us. | Constraints/difficulties during the learning is in the phase of action with instructors from the Incision. The value is we could have access to learning materials anytime and anywhere. Yes, with Incision learning materials more easily understood. The value of Incision is we could have access to learning materials anytime and anywhere. Yes, with Incision learning materials more easily understood because the real picture given by 3D program. |
| R3         | Universitas Gajah Mada | Values over Incision Academy is a learning media that comes with 3D video allows us to learn more completely understand the operating procedure, and then practically closer to the original condition at the time of surgery. | Yes. After viewing the videos using cadaver that is still lacking in a 3D video, it becomes a better understanding of anatomy. | Constraints/difficulties during the learning is in the phase of action with instructors from the Incision. The value is we can learn more easily, can understand, and facilitated the learning process for us. | Constraints/difficulties during the learning is in the phase of action with instructors from the Incision. The value is we could have access to learning materials anytime and anywhere. Yes, with Incision learning materials more easily understood. The value of Incision is we could have access to learning materials anytime and anywhere. Yes, with Incision learning materials more easily understood because the real picture given by 3D program. |
| R5         | Universitas Airlangga | The added value of the program is that e-learning materials and 3D lecture can improve our understanding of the surgical technique and anatomy. | Yes. After viewing the videos using cadaver that is still lacking in a 3D video, it becomes a better understanding of anatomy. | Constraints/difficulties during the learning is in the phase of action with instructors from the Incision. The value is we can learn more easily, can understand, and facilitated the learning process for us. | Constraints/difficulties during the learning is in the phase of action with instructors from the Incision. The value is we could have access to learning materials anytime and anywhere. Yes, with Incision learning materials more easily understood. The value of Incision is we could have access to learning materials anytime and anywhere. Yes, with Incision learning materials more easily understood because the real picture given by 3D program. |
| R10        | Universitas Gajah Mada | The value of Incision is we could have access to learning materials anytime and anywhere. Yes, with Incision learning materials more easily understood. | Values over Incision Academy is a learning media that comes with 3D video allows us to learn more completely understand the operating procedure, and then practically closer to the original condition at the time of surgery. | Constraints/difficulties during the learning is in the phase of action with instructors from the Incision. The value is we can learn more easily, can understand, and facilitated the learning process for us. | Constraints/difficulties during the learning is in the phase of action with instructors from the Incision. The value is we could have access to learning materials anytime and anywhere. Yes, with Incision learning materials more easily understood. The value of Incision is we could have access to learning materials anytime and anywhere. Yes, with Incision learning materials more easily understood because the real picture given by 3D program. |
| R8         | Universitas Airlangga | Yes. After viewing the videos using cadaver that is still lacking in a 3D video, it becomes a better understanding of anatomy. | Constraints/difficulties during the learning is in the phase of action with instructors from the Incision. The value is we can learn more easily, can understand, and facilitated the learning process for us. | Constraints/difficulties during the learning is in the phase of action with instructors from the Incision. The value is we could have access to learning materials anytime and anywhere. Yes, with Incision learning materials more easily understood. The value of Incision is we could have access to learning materials anytime and anywhere. Yes, with Incision learning materials more easily understood because the real picture given by 3D program. | Constraints/difficulties during the learning is in the phase of action with instructors from the Incision. The value is we could have access to learning materials anytime and anywhere. Yes, with Incision learning materials more easily understood. The value of Incision is we could have access to learning materials anytime and anywhere. Yes, with Incision learning materials more easily understood because the real picture given by 3D program. |
| R12        | Universitas Airlangga | The value of Incision is we could have access to learning materials anytime and anywhere. Yes, with Incision learning materials more easily understood. | Constraints/difficulties during the learning is in the phase of action with instructors from the Incision. The value is we can learn more easily, can understand, and facilitated the learning process for us. | Constraints/difficulties during the learning is in the phase of action with instructors from the Incision. The value is we could have access to learning materials anytime and anywhere. Yes, with Incision learning materials more easily understood. The value of Incision is we could have access to learning materials anytime and anywhere. Yes, with Incision learning materials more easily understood because the real picture given by 3D program. | Constraints/difficulties during the learning is in the phase of action with instructors from the Incision. The value is we could have access to learning materials anytime and anywhere. Yes, with Incision learning materials more easily understood. The value of Incision is we could have access to learning materials anytime and anywhere. Yes, with Incision learning materials more easily understood because the real picture given by 3D program. |
Data availability
F1000Research: Dataset 1. Answers for Ritzman questionnaire about the perception of INCISION e-learning in the intervention group., https://doi.org/10.5256/f1000research.15799.d227255

F1000Research: Dataset 2. Raw data for pre and post test scores in both control and intervention groups., https://doi.org/10.5256/f1000research.15799.d227256

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Supplementary material
Supplementary File 1: Pre- and post-test used.
Click here to access the data

Supplementary File 2: Ritzman questionnaire about the perception of INCISION e-learning.
Click here to access the data

Supplementary File 3: Conventional Hysterectomy Course Schedule.
Click here to access the data

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Peer review discontinued

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The efforts are laudable and adequate weightage can be given since it is a multi-center study but I would like to mention that in the title it is mentioned “to enhance knowledge and skills”, out of which only knowledge is tested.

It is mentioned only in the Abstract regarding Direct observation of Procedural Skills, but it was nowhere mentioned in the main text, neither was it evaluated which it should have been, as it could test the skill component as well as performance. The module could also be explained in detail.

In the Methodology, study design and sampling technique is not mentioned. Kindly explain the part in the Methodology - Procedure; that the residents took the exam at least once during the week after the study period.

In the Discussion, the present study is not discussed in light of other studies.

In the conclusions, it is mentioned that there were significant differences in knowledge and skill. If skills were nor assessed, this statement can’t be made.

Is the work clearly and accurately presented and does it cite the current literature?
Partly

Is the study design appropriate and is the work technically sound?
Partly

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
Yes

Are all the source data underlying the results available to ensure full reproducibility?
Yes
Are the conclusions drawn adequately supported by the results?
Partly

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** Medical Education Technology

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

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