Journal of Engineering Education Transformations
Volume 37, No. 2, October 2023, ISSN 2349-2473, eISSN 2394-1707

10.16920/jeet/2023/v37i2/23152

Teaching Engineering Graphics through Digital Presentations for Engineering Students

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Abstract: All new students at the University of Prishtina “Hasan Prishtina”, Faculty of Mechanical Engineering, take an Engineering Graphics course in the first semester. The subject is divided into two sections: Technical Drawing and Descriptive Geometry. To teach lectures, professors use didactic equipment such as LCD projectors and drawing on the table. Assistants demonstrate exercises by drawing mechanical parts in the table. In 2014, teachers began using digital presentations with animations in their lectures. They contain developed presentations using PowerPoint software with step-by-step animations of mechanical parts. The paper examines the effectiveness of this methodology from both the student and teacher perspectives. The study is based on a survey of students, teachers' experiences, and a comparison of exam results. The analysis discusses the methodology's effectiveness, presentation quality, knowledge gained, ease of learning, impact on exam pass rate, and other benefits.

The following are some key findings from this paper: students accept and favor this teaching methodology; it is more effective than hand drawing; it has a significant impact on exam pass rates; and it is simple to understand the lectures. Teachers like this methodology because it allows for step-by-step explanation with animations; repeating options; presentations are created only once, easy corrections, developing many examples of mechanical parts with less effort, and students can easily access them.

The paper contributes to a new teaching methodology for students in their first year of Engineering studies, Bachelor level, in the subject of Engineering Graphics.

Keywords: Engineering graphics, Teaching methodology, Digital presentations, Animations, Higher education, Teaching survey.

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1. Introduction

The objective of the Engineering Graphics course is to teach students how to represent objects on plain paper or in digital form, as well as how to describe them in an appropriate view and description that is understandable for the reader with engineering knowledge (M. Bajraktari & I. Doçi, 2012). In the course context, students use manual freehand drawing to create a sketch of an engineering device or part. They define the orthogonal or perspective views on paper, scale the drawing, and apply engineering-standard dimensions. The materials, cuts, and surface quality are then applied. Lecture classes can have up to 80 students, and exercise classes can have up to 25 students. To pass the subject, students enter the exam, where they draw on plain paper the given tasks. The semester-long course consists of two hours of lectures and two hours of exercises per week (Self Evaluation Report, 2018). Lessons last 15 weeks total, with 30 hours of lectures and 30 hours of exercises per semester. Lectures are held in classrooms equipped with whiteboards and LCD projectors. Students are taught the exercises by drawing mechanical parts on the Classroom Board using Markers and drawing tools such as triangle rulers, compasses, protractors, and other scales.

Teachers of the subject began developing and implementing lecture presentations using PowerPoint software in 2014, including not only images and textual content but also animations of drawings. The outcomes were encouraging.

The main reasons for implementing the method were few and simple:

a. Previously, lectures were taught by professors with drawings of examples of mechanical parts on the chalkboard. Drawing by hand on a table took too long, and the subject's broad curriculum could not be completed in time (M. Bajraktari & I. Doçi, 2012). More drawings of mechanical parts can be explained using digital presentations, and the curriculum goals can be met.

b. The most common complaint from students was difficulty seeing the drawings on the board, especially from the back rows. Even from a close distance, the small details of the drawings were difficult to see. Using presentation, seeing the drawings is much better, while the teacher can also zoom the drawing (D. Xingeng and L. Jianxiang, 2012)

c. Drawings are clearer in digital presentations. Details, parts, and symbols can be distinguished more easily, which is useful in engineering graphics. Another advantage of digital presentations is the use of colors to distinguish parts.

d. Drawing in the table by hand cannot be repeated for the same mechanical part drawing. Students can learn these drawings by repeating them as many times as they want using presentations because they are in file form and can be downloaded and used with the PowerPoint software.

e. Hand drawing is a step-by-step explanation, not an animation. Students tend to forget the process of sketch development. PowerPoint digital presentations provide step-by-step animation that the student can review at any time. It can also be reviewed by the teacher in order to improve the presentation or as a good foundation for creating additional mechanical parts presentations.

f. Teachers still use hand drawings for extended explanations on occasion. Dimensioning can benefit from the combination of digital presentations and some drawings on the board, for example.

The main gap to fill at first was the students' and professors' level of proficiency in PowerPoint, as well as reading and developing presentations. The proficiency requirement for new software was both a curriculum addition and a new load. However, everything went fine. Students had previously learned the software in high school. The professors who teach the subject are young and very knowledgeable about Office software.

PowerPoint software is introduced by Microsoft Corporation in 1987 as part of the Microsoft Office package (Microsoft PowerPoint, 2016). PowerPoint is appropriate software in a visual and descriptive way for lectures with students (Microsoft PowerPoint, 2016; Victoria Sage, 2017; Uz et al., 2010). It is a very effective software for the presentation of lectures in Engineering Graphics, though academics continue to debate whether drawing on board is superior to digital presentations (S. Brock & Y. Joglekar, 2011; Hamdan & Altaher, 2011).

The following is how the paper is structured: Section 2 discusses Literature Review by summarizing authors' work on this topic. Section 3 describes the process of creating Presentations in Technical Drawing based on the Curriculum. Section 4 describes the process of creating Presentations in Descriptive Geometry. Section 5 denotes the evaluation of the students' satisfaction rate via survey, using questionnaires, as well as the efficiency of the methodology in the exam-passing rate. The Questionnaire is distributed to students in the form of five tables. Table 6 shows the exam results as well as a comparison of the methodology's efficiency. Discussions based on the Results and Analysis, as well as comparisons with results from other authors, are included in Section 6.

2. Literature review

Contributions in this field are published by various authors and institutions with the presentation of best practices in teaching with digital presentations.

Gamabari et al. (2015) conclude in their paper that there is a significant difference in learning outcomes in favor of the group taught technical drawing concepts using PowerPoint presentations. They polled the students and they prefer digital presentations for teaching.

Hamndan et al. (2011) present research that identifies and quantifies the benefits of using PowerPoint software to teach engineering students at the college level. They conduct a student survey. In conclusion, students prefer PowerPoint presentations for their clearly organized lecture structures, and while PowerPoint is a powerful tool for delivering lectures and assisting instructors in reaching a wider audience level, it does not guarantee that students will remember lecture information for an extended period of time.

In their paper, Çidem Uz et al. (2010) present lecturers' opinions about the PowerPoint presentations used in their teaching in order to identify the factors students are satisfied with and those that could be improved, as well as the results that provide insight into the future use of PowerPoint presentations for academics. They survey students about their opinions about PowerPoint presentations. They conclude that their findings are applicable to positive multi-media education principles in a variety of subjects. They mention that teachers from various departments of Faculties of Education had partially positive opinions about the PowerPoint slide designs. Students' responses were "partially" positive, owing primarily to inappropriate slide designs by some teachers. Students from various departments had varying opinions. Students in computer education... gave PP presentations a lower rating because they understand design principles and have the ability to criticize, whereas students in Religious and Ethics Education gave PP presentations a higher rating because they see PP presentations as an effective way to concretize abstract concepts.

According to Jacek Uziak et al. (2021), modern ICT is rapidly growing and being adopted in enhanced teaching classrooms and environments. They recommend that instructors use a hybrid technique that combines chalk and talk and PowerPoint, after determining which areas of the course will benefit the most from either technique.

Elhaini Jamila (2020) introduces a new flipped classroom method with a new structure based on a PowerPoint presentation that was implemented to train students with the soft skills required in the Industry 4.0. The industrial engineering class received the flipped course.

Ding Xingeng & Jianxiang (2012) present the Advantages and Disadvantages of PowerPoint in Lectures to Science Students. They list a few advantages of PowerPoint: producing better visual effects and a deeper impression, speeding up information transfer, being more precise and systematic. They list the following disadvantages: irrelevant information may be harmful, lack of interaction with students may turn a lecture into a monologue, and high speed may reduce student participation. In a survey of students, the majority (81.7%) preferred a combination of PowerPoint presentation and "chalk-and-talk" lecture. They also suggest strategies towards implementing PowerPoint as an assistant tool in education.

Gary D. Fisk (2019) explores the use of PowerPoint in education, including its benefits and drawbacks, in his book. Bright future of usage in education, but also criticisms. And the need for clear guidelines to inform educators about the best ways to use it.

In their study, S. Brock and Y Joglekar (2011) state that the use of presentation software such as PowerPoint varies depending on the instructors' teaching styles. The relationship between the number of PowerPoint slides used in class and perceived teaching effectiveness is not very strong; rather, the character and use of slides is the main focus of student feedback.

D. Speranza et al. (2017) presented some online tools for teaching technical drawing to students that were implemented in three Italian universities. These tools included an online Interactive self-learning tool for teaching manufacturing dimensioning using video and drawing animations, an online self-assessment test, and an online questionnaire in technical drawing. They conclude that the developed learning tools are effective, and the preliminary results of their use are promising.

M R Clinciu and R Clinciu (2021) present some innovative methods for teaching the fundamental concepts of technical drawing to students in technical faculties. The majority of these methods are ICT-based, online, and utilize virtual reality and CLOUD storage systems.

This paper shares similarities with the methodology of Power Point presentations with the literature. As previously stated, there are numerous papers that describe the effect of this method. The methodology of presentations with animations in this paper is unique to the Engineering Graphics subject. We propose an improvement in the method of presenting Descriptive geometry tasks and examples. There are similarities in the questionnaire structure in some topics, for example, with idem Uz et al. (2010), but there are also different impressions required by the students, which are based on the subject teachers' long-term experience.

Some conclusions are similar to the literature mentioned above, particularly in terms of the effects of presentations on students' knowledge, but this was not surprising. However, there are some unique conclusions, such as the benefit of step-by-step animations of drawings and the order of steps, the importance of colors to distinguish parts of drawings, better visibility of drawings in lectures, easy implementation of drawing rules in presentations, and the ability to implement all examples of drawings planned in the curriculum in presentations.

3. Development of Presentations in Technical Drawing

Based on the subject's curriculum, 13 presentations have been developed for each Chapter in Technical Drawing to fulfill the curriculum. (M. Bajraktari& I. Doçi, 2012):

1. Introduction to Engineering Graphics,
2. Types of Technical Drawing,
3. Standards and standard numbers,
4. Types of drawing lines,
5. Scales, tables, and Formats,
6. Drawing basic and advanced geometry entities and shapes,
7. Technical drafting and symbols,
8. Dimensioning and tolerancing,
9. Definition of materials in technical drawings,
10. Representation of Surface treatment and coating in technical drawing,
11. Projections in Technical drawing,
12. Sections of mechanical parts,
13. Representation of mechanical parts in technical drawing.

Chapters with important presentations with animations include Chapters 6, 8, and 13. Other chapters have fewer animations and less dynamic text and image presentations. Animations are an effective way of passing on knowledge to students because they can see the progress of the example in real time (D. Speranza et al., 2017). Development of presentations consists of step-by-step inclusion of drawing elements, using *Add Animation* Option. The Animation Pane is shown on the right side of the software interface in Figure 1. The animation consists of two main actions: *Entrance* (typically with the *Appear* option) and *Exit* (typically with the *Disappear Option*). 'Animation' is the process of developing a drawing task using the Animation Toolbar and Animation Pane of the Power Point Software to organize the insertion of drawing parts in their development order. (Microsoft PowerPoint, 2016).

All parts of the drawings should be drawn in the presentation Slide before proceeding to the animation option. This includes the textual explanations. The language of presentations is Albanian, as the studies.

Chapter 13 of the Curriculum - *Representation of mechanical parts in technical drawing* is the summary of all Chapters in Technical drawing part. It contains complete solved examples of drawings of mechanical parts and assemblies. This is the main part of the Curriculum in the Technical Drawing.

Figure 1 depicts a task example that needs to be drawn and animated. It is an axonometric view of a mechanical part with parts, dimensions, surface treatment, and text that explains requirements and to-do tasks (Sh. Lajqi, 2014).

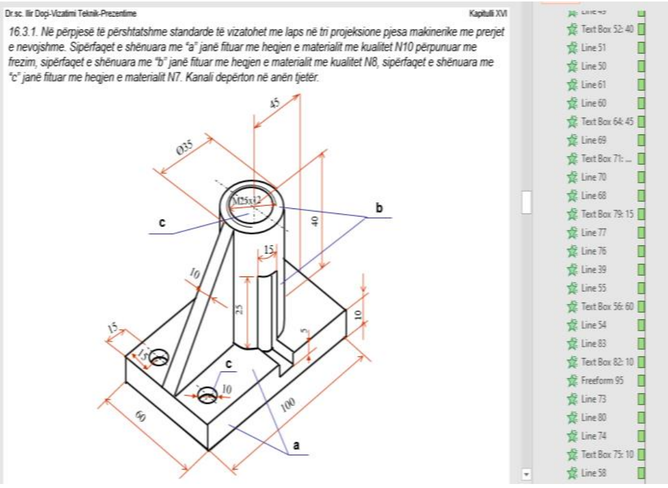

Fig. 1. Technical Drawing- Example of mechanical part presented in three orthogonal projections

The mechanical part needs to be presented (drawn) in 3 orthogonal projections with all the necessary elements that are required by the rules of ISO standards for drawing of mechanical parts (*ISO Technical Drawings in General* ; *ISO Mechanical Engineering Drawings)*. All the elements are given in *mm* dimensions, and they will be drawn in same units in presentations. There are included 69 elements on 3 animation groups. Animation group's means the group of more than one element that appears in the presentation at the same time. Usually, the groups are organized based on the importance of appearance at the same time, their mutual interconnection or for explanation purposes. A point, for example, can appear with its label (naming), a line (segment) can appear with its end points and labels, and so on.

In the Fig. 2 is given the second part and solution of the given task in Figure 1, with all the elements for representing mechanical parts on three orthogonal projections. There are 166 elements on 108 animation groups included. The inclusion of elements is by clicking, with either mouse or keyboard. The other option, using the timing in seconds, is deemed inappropriate by teachers, as there are times when more time is required for explanations, and it is sometimes necessary to go backwards on some steps.

Important task on the preparation of presentations is exact drawing of parts and exact implementation of rules of ISO Standards for technical drawings (S. Labisch et al., 2017; Sh. Lajqi, 2014).

Another important task is planning the order of steps in the appearance of parts as drawings progress (I. Doçi, 2015). Parts of the drawing must appear in the correct order, as they would be drawn with a pencil on paper or with chalk on a table (J. Uziak et al., 2021; H. C. Spencer, 2016). The following is the order of appearance and development of parts in the step-by-step process:

1. Table of drawing with all the data and lines of general axes,
2. Lines of the object drawn, including symmetry axes, starting from second projection (upper left), first projection (bottom left) and third projection (upper right). Here are included auxiliary lines between projections. The order of animating projections can be switched,
3. Dimensioning and tolerances,
4. Sections and cuttings, where applicable,
5. Surface treatment and coating symbols,
6. Removal of Auxiliary lines.

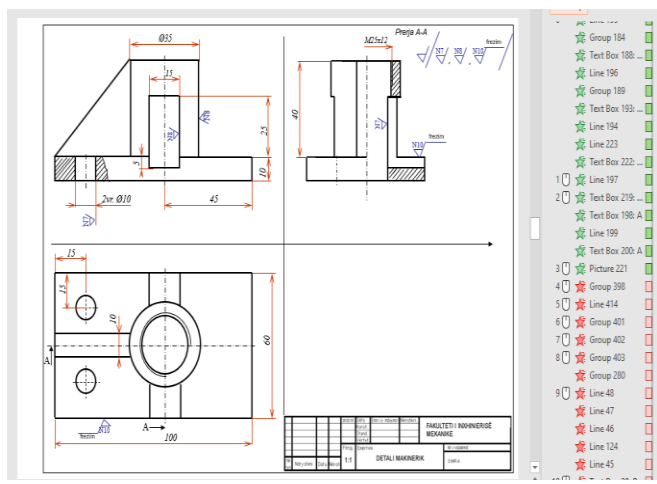

Fig. 2. Technical Drawing- Solution of drawing of the the example in Fig.1, presented in three orthogonal projections

4. Development of presentations in Descriptive Geometry

Descriptive Geometry is the second part of the curriculum in the subject of Engineering Graphics in the Faculty of Mechanical Engineering. It is the representation of three-dimensional objects in two dimensions, including their position in space and plane, as well as their mutual relationship, while adhering to processes and principles (M.Bajraktari & I.Doçi, 2012).

Tasks and examples in Descriptive Geometry are very well suited to be taught using PowerPoint. In particular, learning through step-by-step presentation and repetition of steps.

Animated presentations in Descriptive Geometry are based on the subject's curriculum. It includes position of points, lines, and planes in 3D and 2D view, transformation and rotation of geometric entities, metric problems, cutting of geometric bodies with a plane, intersection of bodies, axonometric representation of mechanical parts, and surface development.

In the Fig. 3 is given an example of the axonometric projection of one mechanical part. It contains 194 elements in 137 animation groups.

Figure 3 shows an example of an axonometric projection of a mechanical part. It has 194 elements organized into 137 animation groups.

Figure 4 shows an example of a presentation that includes the intersection of Cone and Cylinder with Animation Pane. This is one of the most complex presentations. The cone and cylinder lay with their bases in the First Projection plane. The presentation includes 508 elements organized into 476 animation groups. This example requires approximately 18 hours of effective work.

Also, in Descriptive Geometry presentations, it is important to plan the order of steps in the appearance of parts during the progress of drawings, as they would be drawn with pencil on paper or chalk on the table.

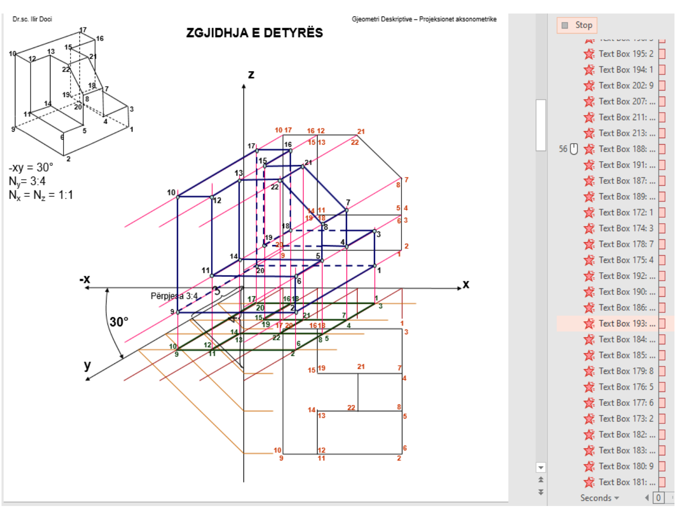

Fig 3. Descriptive Geometry- Example of mechanical part in axonometric projection

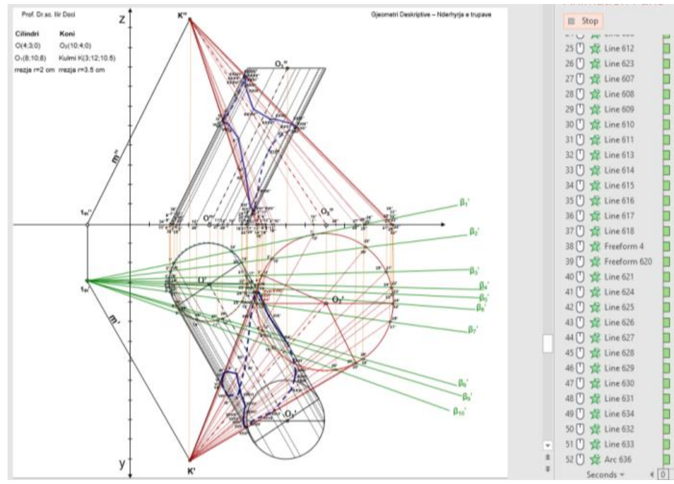

Fig. 4. Descriptive Geometry- Example of Intersection between Cone and Cylinder

5. Survey with students -evaluation and analysis

To evaluate and analyze the impact of this methodology, a survey with questionnaires was conducted with students. Survey was conducted at the end of the Winter Semester 2019. The survey had 75 student participants, representing the entire group of students in the Department who attended the Engineering Graphics Lectures.

A questionnaire survey was used to gather student feedback on the effectiveness of animated digital presentations in Power Point Software.

The questionnaire for the survey is developed based on the hypothesis of the authors in (A. I. Gambari et al., 2015; M. O. Hamdan et al., 2011), questionnaires in (Ç. Uz, et al. 2010; M. O. Hamdan et al., 2011), experiences in teaching students in Engineering Graphics in a long-term basis (I. Doçi, 2015) and reports from Faculty surveys (Self Evaluation Report, 2018). It contained 5 Groups of Impressions:

A. *Student's proficiency of Power Point Software.*

B. *Impressions related to Slides Layout.*

C. *Impressions related to the Descriptive Text in Slides.*

D. *Impressions related to the Visuals and animations in presentations.*

E. *Impressions related to the Contribution to Learning.*

Each Group contained four scales of topic impressions. Impressions are organized in a Likert Scale format (Likert Scale...2020), with a four-point rating scale: *Completely satisfactory*, *Good*, *Poor*, and *Not Helpful*. The questionnaire was distributed to students at the end of the Winter Semester lectures.

The results of the Survey are represented in the table form, with tables containing specific group of impressions (A. I. Gambari et al., 2015; Ç. Uz et al., 2010; J Uziak et al., 2021). They contain collection of responses from students in the survey, with answers sorted based on Satisfactory scale.

Table 1. Impressions about the student's proficiency of Power Point software

Scale	Impression	Number of respondents	%
Completely satisfactory	**1.** I have excellent knowledge in Power Point Software and had no problems using presentations with animations	53	70.67%
Good	**2.** I have good knowledge of Power Point Software but I had to learn how to use presentations with animations	15	20%
Poor	**3.** I had poor knowledge of Power Point Software and I had to learn it in meantime to use presentations	7	9.33%
Not helpful	**4.** I do not know Power Point Software	0	0%
	Total	**75**	100%

According to the results in Table 1, students have no trouble using Power Point software and accessing presentations. Office programs were taught to students in high school.

Table 2. Impressions related to slides layout

Scale	Impression	Number of respondents	%
Completely satisfactory	**1.** The layout and the design of the slides help me to understand the subject as a whole	42	56%
Good	**2.** The layout and the design of the slides help me to understand the subject partially	19	25.33%
Poor	**3.** I can understand important points about the subject from the layout and the design of a slide.	12	16%
Not helpful	**4.** The layout and the design of the slides don't help me to understand the subject	2	2.67%
	Total	**75**	100%

The importance of slide layout for student knowledge gain can be seen in the results in Table 2. The higher percentage of *Poor* and *Not helpful* indicates that there is more work to be done with students to explain the layout of slides, which is closely related to mechanical drawing rules, and to improve the step-by-step animations.

The satisfactory percentage of text explanations for mechanical drawing examples can be seen in the results of Table 3. The text in slides appears as an intermediate explanation of the task explained. A high percentage of *Completely Satisfactory* and *Good* scales indicates that the students accepted and understood the text in the slides.

Table 3. Impressions related to the descriptive text in slides

Scale	Impression	Number of respondents	%
Completely satisfactory	**1.** The descriptive text in Slides help me to understand the examples and tasks completely	54	72%
Good	**2.** The descriptive text in Slides help me to understand the examples and tasks partially	13	17.34%
Poor	**3.** There should be more descriptive text for explanation of examples and tasks	7	9.33%
Not helpful	**4.** I can't understand the text in Slides	1	1.33%
	Total	**75**	100%

We believe that the results in Table 4 (shown below) are the most important in terms of the effects of animated presentations. Students confirm that visuals and animations help them understand the examples of drawings in a high percentage of *Completely satisfactory* scale (82.66%).

Table 4. Impressions related to the visuals and animations in presentations

Scale	Impression	Number of respondents	%
Completely satisfactory	**1.** The visuals and animations in Slides help me to understand the examples and tasks completely	62	82.67%
Good	**2.** The visuals and animations in Slides help me to understand the examples and tasks partially	5	6.66%
Poor	**3.** There should be more visuals and animations for explanation of examples and tasks	8	10.67%
Not helpful	**4.** The visuals and animations don't help me to understand the examples and tasks	0	0%
	Total	**75**	100%

Table 5. Impressions related to the contribution in learning

Scale	Impression	Number of respondents	%
Completely satisfactory	**1.** Lectures with Presentations are sufficient to help me learn the subject	39	52.7%
Good	**2.** I understand lectures with presentations, but I would prefer to be combined with handwriting in the Board	26	35.13%
Poor	**3.** I would prefer the lectures to be taught using handwriting on the Board	7	9.45%
Not helpful	**4.** Lectures with presentations don't help me to learn the subject	2	2.70%
	Total	**74 ***	100%

* – *One student did not give the answer.*

According to the results in Table 5, the majority of students are completely satisfied with the effect of presentations on learning the subject. The *Good* scale response of 35.13% indicates that for some students, exercises with handwriting in Board are still necessary for understanding the subject. The encouraging result is that the percentages on the *Poor* and *Not helpful* scales are very low, indicating that students accept this style of lecturing.

Fig.5. Survey chart of the satisfactory rate in %, based on 5 impressions

The graph in Fig.5 depicts the percentage of four-point satisfactory scales organized by five impressions: *A. Student's proficiency of Power Point Software; B. Impressions related to Slides Layout; C. Impressions related to the Descriptive Text in Slides; D. Impressions related to the Visuals and animations in presentations; E. Impressions related to the Contribution to Learning.*

The chart in Fig.6 displays the average results for each of the four 4-point satisfaction rates.

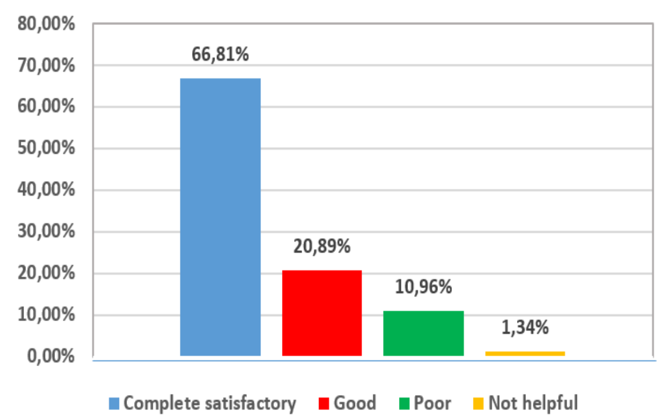

Fig.6. Ave rage results of the Survey satisfactory rate in %

According to the survey results in Figs. 5 and 6, students are satisfied with the digital presentations in lectures. On average, the overall satisfaction rate is 66.81%. When the Good rate (20.89%) is included as a satisfactory result, the overall positive satisfaction rate (Completely satisfactory + Good) is 87.7%. It's worth noting the extremely low *Not Helpful* rate of 1.34%.

5.1. Effects on the exam results

Results of the exams in Engineering Graphics were analyzed with the comparison of the passing rate before and after the implementation of digital presentations. The implementation of digital presentations with animations in lectures began in October 2014. The first exam term after that was in January 2015. Three exam terms were included in the analysis: January, April, and June.

The results include the passing rate from 2014 to 2019, prior to the COVID-19 pandemics. The analysis results are shown in Table 6.

Table 6. Results of exam in engineering graphics after the implementation of digital presentations (2014-2019)

Year of Lectures	*No. of students in exam*	*January Term*	*April Term*	*June Term*
2014 (before presentations)	Total students	59	33	19
	Passed exam	25	15	8
	% Passed	*42.37%*	*45.45%*	*42.11%*
	Average of exam success	**43.31%**		
2015 (with presentations)	Total students	80	43	26
	Passed exam	38	21	12
	% Passed	*47.50%*	*48.84%*	*46.15%*
	Average of exam success	**47.50%**		
2016	Total students	68	41	20
	Passed exam	31	20	9
	% Passed	*45.59%*	*48.78%*	*45.00%*
	Average of exam success	**46.46%**		
2017	Total students	62	43	25
	Passed exam	28	19	12
	% Passed	*45.16%*	*44.19%*	*48.00%*
	Average of exam success	**45.78%**		
2018	Total students	57	34	27
	Passed exam	27	17	12
	% Passed	*47.37%*	*50.00%*	*44.44%*
	Average of exam success	**47.27%**		
2019	Total students	48	17	16
	Passed exam	23	8	9
	% Passed	*47.92%*	*47.06%*	*56.25%*
	Average of exam success	**50.41%**		

6. Discussions

The survey and analysis results show that students accepted this methodology well. It aided them in learning this subject and passing the exam. Students rate it as user-friendly, understandable, and easily accessible. Other benefits include step-by-step learning of mechanical parts drawings, the ability to repeat tasks forward and backward, and the use of presentations as a reference for learning other examples (E. Jamila, 2020; G. D. Fisk, 2019). While it is computer-based and file-based, it can be easily downloaded from the University Intranet or other online storage systems and used whenever it is convenient (M. R. Clinciu & R Clinciu, 2021).

Exam passing rates improved, according to the results in Table 6. Exam passing rates increased from 43.31% (2014) to 47.50% (2015) in the same year that digital presentations were evaluated (2015). This is a significant increase and success rate in our opinion. Furthermore, it provided confidence in the methodology's success. The results remained high in the following years (2016, 2017, and 2018), ranging from 45.78% to 47.27%. The year 2019 has the best results, with 50.41%. This is the first time that the passing rate has surpassed 50%.

The most difficult challenge is preparing PowerPoint slides, preparation of drawings in slides, adding animations in the correct order, and implementing the rules of teaching engineering graphics that must be implemented while preparing PowerPoint slides. This may appear to be tedious and time consuming at first, but the preparation of drawing tasks in slides is done only once. Preparing new drawing examples from existing ones is simple and less time consuming than drawing from scratch with a pencil and hand. Students spend less time learning from presentations than they do reading and learning from books (D. Xingeng & L. Jianxiang, 2012).

Table 5 of this paper demonstrates that ppt is superior for teaching engineering graphics and will remain so in the future. Based on the results of the exams, there have been a rise in the passing rate. This is the same as the finding of a. i. Gambari et al. (2015), students exposed to ppt presentations performed better since ppt had the highest posttest performance mean when compared to chalkboard instruction.

The impact of this methodology can be seen in the exam pass rate and ease of comprehension of the lectures. The results in Table 6 show that the passing rate has increased over time in all exam terms. The January Exam Term results have improved from 42.37% (2014) to 47.50% (2015) to 47.92% (2019). A 5% increase is considered a good result. The January exam term is significant because it is the first exam term for the new generation of students in this subject and has the highest number of students taking the exam (59 in 2014, 80 in 2015, 68 in 2016, 62 in 2017, 57 in 2018, 48 in 2019). As a result, it has the highest percentage of students passing the exam (25 in 2014, 38 in 2015, 31 in 2016, 28 in 2017, 27 in 2018, and 23 in 2019). This is a critical exam term for analyzing and drawing conclusions. Other Exams terms, such as April Term, have a smaller number of students taking the exam, so the results can vary statistically. Another important reason is that the best students have already passed the Exam in January, so the results for the April term and subsequent exam terms can be close with small percentage changes.

There is some debate about whether there are better tools than PowerPoint for students and teachers in Engineering Graphics lectures. There are computer-drawing tools that can be used instead of chalk, board, pencil, and paper (H. Wang & CH. Pan, 2013). However, computer drawing tools lack the ability to progress drawing examples step by step, as well as the ability to repeat and animate. Mostly, the computer mouse and keyboard replace the chalk or pencil. Students should use them after learning the principles of engineering graphics. Their main advantage is the option of 3D representation, which could be useful in axonometric view, but Power Point also has some good computer drawing tools, including the ability to manually draw the axonometric view. There are online tools, such as Google Board, that are similar to online computer drawing tools, but have limitations in Engineering Graphics. Online tools necessitate reliable Internet access, which is still weak in our classrooms.

Using digital presentations with animations requires computers, in our case laptops, with installed PowerPoint software. There are presentations with up to 508 elements and 476 animation groups, and the content and animation transitions were feared to overload the laptops. The first test presentation was created in 2014 on a Dell Optiplex 390 Desktop Computer with an Intel Core i3-2100 processor running at 3.1GHz and RAM memory of 4GB DDR3. The computer handled presentations and animations well. Teachers' laptops had comparable or better specifications. In the years that followed, older laptops and desktop computers were replaced with newer models. Computers with an Intel Core i3 processor or higher and RAM memory of 8GB DDR3 will handle the large number of animations without issue.

7. Conclusions

Digital presentations using Power Point software assist students in learning the subject more easily and effectively. They also assist teachers in improving their lectures and transferring knowledge to students. This paper's research examines the advantages and disadvantages of this methodology. Based on the survey results and the exam pass rate, we can conclude that switching from handwriting to digital presentations is effective in increasing students' knowledge gain.

This method is more effective than hand drawing. The following factors contribute to the effectiveness: development of presentations is done only once for the drawing example, better visualization, step-by-step explanation, option to repeat the explanation steps, use of colors to distinguish parts, in and out zoom option.

Students accept and prefer this methodology, which is based on a survey and graphical representation. Teachers will occasionally use a marker and handwriting to provide additional explanation, but only when referring to actual slides on the screen. Handwriting with a marker or chalk on a drawing board is still used as a method of instruction in the exercises section, which is taught by the assistants. This may change as new Smart Board technologies emerge. In that case, the advancement of new teaching and training hardware and software technologies will propel Engineering Graphics education forward.

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