

# Students Perceptions on the Use of AutoCAD Activities in Courses of the Mining Engineering Program

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## Abstract

AutoCAD is a professional tool used by engineers, architects, designers, and other professionals worldwide. Particularly in mining engineering, AutoCAD has been used to facilitate the teaching quality of the specific content of modeling, design of geological anomalies, tunnels, ramps, and plan readings. In addition, used in university settings, it can be an excellent tool for collaborative learning and developing social skills that involve students. This contribution investigates the perception of mining engineering students on AutoCAD in their courses regarding its value as a computational tool and its intense use of digital resources. We used a Likert-type survey of mining engineering students from a large private university in Chile to collect the data. The results show that the acceptance given by students to the use of AutoCAD as a design and three-dimensional modeling tool is very favorable. AutoCAD tools facilitate students' management and construction of knowledge since they can progress at their own pace. Course results show a lack of training in technological skills by students. We recommend strengthening students' digital literacy with activities in previous courses.

**Keywords:** AutoCAD, collaboration, learning, educational innovation, higher education, STEM education.

## Introduction

AutoCAD is a professional tool used by engineers, architects, designers, and other professionals worldwide [1]. Particularly in mining engineering, AutoCAD has been used to facilitate the teaching of specific contents in modeling, design of geological anomalies, tunnels, ramps, and reading of drawings [2]. In Chile, the mining industry has been using AutoCAD for several years now, and time is needed to train newly hired engineers on how to use it.

The course described in this paper was designed in line with the employment conditions and the new educational models that place the student at the center of the teaching-learning process. This course was designed for Mining Civil Engineering students from a private university in Chile. Thus, the subject was applied to a homogeneous sample, as students share common traits or interests and study the same program. The subject lasts a whole semester, with a maximum enrollment of 45 students, and it sits in with the "General Training Elective" study plan, designed for the first semester of each year. The main issue is generating activities whose purpose is to evaluate progress class-by-class and promote pedagogical interaction.

In the course approach, the instructor is not the sole repository of knowledge and becomes more of a facilitator of student learning. Under this process, the instructor monitors academic concerns, guiding and orienting student training through timely feedback, respect for talent diversity, and active learning techniques. The process focuses on designing a program for students to

progressively acquire the knowledge required for practical application through activities that may facilitate learning and motivate students.

Being a relatively recent innovation, as forced by COVID 19, online education guides the use of new technologies in developing alternative methodologies for student learning. While the learning process, at present, requires self-learning and the ability to deal with activities autonomously, this sits well with the stated need to introduce virtual learning strategies and skills into university education.

In this context, we sought to design a course that facilitates assimilation and aims for interaction between students and instructors that may deliver dynamic learning activities. Under this analysis, the AutoCad General Training elective course was offered to generate skills that may allow for understanding the importance of drawings. For example, the VULCAN software that is commonly used in any professional activity in earth sciences is available for students to develop mine modeling and design activities from drawings generated from AutoCAD. In addition, it is an essential tool in job requirements.

The main objective of this work is to implement a course to improve student learning through the design and application of an elective course focused on the use of AutoCAD tools by Mining Engineering students.

According to the above, the objectives of this work are

- Provide a diagnostic of the needs Mining Engineering students have.
- Design an elective course in AutoCAD to apply the software in a Mining Engineering college degree.
- Implement the elective course focused on AutoCAD software in the Mining Engineering college degree students.
- Evaluate the results of the AutoCAD software application by administering a satisfaction survey.

### **Theoretical foundation**

The project corresponds to incorporating an elective course into the program curriculum. The development of activities must be continuous and progressively interrelated, and support material is designed to favor the student's learning process. The activities must complement individual advancement and stimulate collective analysis in constructing each stage of the course.

This task must facilitate the individual's construction of his subjective identity. Recreating culture requires close and constant attention in a social space of experimental and alternative exchanges, shared experiences, and intellectual contrasts [3]. This process has two approaches that are not dichotomous, strengthen individuality and generate team interdependence. Therefore, it is necessary to generate activities and indicators that evaluate individual and collective capacities and abilities.

As supported by Information and Communication Technologies (ICT), the paradigm emerging in this new era of learning must be done within an environment of tolerance, open to dialogue and

negotiation, listening to proposals that seek favorable results, and democratizing opinions and points of view. All of them are fundamental skills in senior management practices.

Given the above, each class requires teamwork, collaboration, and complementing opinions to develop a professional environment. Aims expected to be achieved interconnection in ICTs, consolidating technical foundations by carrying out activities that are easy to assimilate and having student teams share their visions by interacting and substantiating their various points of view.

Only through the expansion of our pedagogical strategies is it possible to generate activities that engage students through the appropriate use of technological opportunities, allowing students to be involved and develop their full creative potential. As Barrios-Taos states [4], the improvement and diversity of the didactic and pedagogical elements accompanied by quality social interactions in learning contexts contribute to enhancing skills.

There is a growing awareness of the benefits of shifting towards a student-centered higher education. The intention is to move from a teacher-centered paradigm, using the teacher and knowledge transfer model, to the new student-centered paradigm through learning and skill-set development, which can then be transferred to other contexts, spaces and times. [5]

The relevance of finding activities that may generate more significant stimulus in adaptive evolution should be highlighted, with classroom processes seeking to generate strong knowledge anchor points. The software thus becomes a bridging link to current generations, facilitating the acquisition of skills through interactive stimuli. Therefore, a more significant acceleration of the adsorption and assimilation process is expected. The software acts as a catalyst, a particular characteristic of a design process that accelerates results [6]. In addition, learning plasticity may also help accelerate the learning process [7].

ICTs may be considered a technological system having greater power and process speed and a facilitator of changes in cognitive activities in a teaching-learning context [8]. Thus, each activity carried out generates different changes in our cognitive activity, depending on the stimuli received and the assimilation achieved. Consequently, with the proper use of software, the brain is subject to constant transformation and offers multiple opportunities to be modified by the different experiences.

The use of ICTs implies the possibility of generating assimilation activities, where each person must explore their potential, generate proposals, and organize them at their own pace. As it has been shown that students learn by doing, instructors should acquire the role of tutors, guiding the student with each activity, using the software as an accelerator [9].

AutoCAD allows managing a database of geometric entities (points, lines, arcs). In this sense, it is possible to operate through a graphic screen on which they are shown. The so-called drawing editor uses model space and paper space to separate the drawing phases in 2D and 3D, from the specific ones to obtain plans drawn on paper at their corresponding scale [10]. Autodesk's AutoCAD software suite is a powerful drawing aid. To handle it effectively, it is not necessary to have computer skills. When drawing with AutoCAD, one does more than create a drawing. Associated objects can be placed on specific layers or grouped to form new sets autonomously. AutoCAD

memorizes locations, sizes, and colors and allows us to continuously rewind and modify or go back step by step to the origin of our drawing. The final product is a clear and precise drawing.

The learning media are a tool to achieve the objectives of learning competence. AutoCAD 3D material is considered difficult to implement, even if it is assisted with modules. In addition, direct training methods require a relatively long time, which is due to the students' diverse abilities. Thus, interactive multimedia development becomes a solution in learning AutoCAD 3D. Students can follow the material that has been delivered or repeat the competitions as needed. With the concept of E-Learning, interactive multimedia is expected to be easier and more flexible in use and accessible to anyone. [11, Muhammad Nurtanto, 2021].

TeamViewer is based on the VNC application for remote control of another computer system. It is free for non-corporate use, and it does not need to be installed on other computers. This possibility is its most significant advantage. In contrast to TeamViewer, all other applications based on the VNC protocol must be installed before use. TeamViewer is ready to make ad-hoc remote connections between PCs. The application is easy to use and works even without local administrative rights, making it unique compared to other VNC-based programs. If we want to use this software, we have to run it on the two machines we want to connect.

## **Methodology**

Hernández, Fernández, and Baptista [12] point out that qualitative research can have different applications in engineering. For example, a study could be considered for a group of experts to communicate in-depth their experiences when using a new construction material or for a researcher to collect the points of view of all participants in a manufacturing process to optimize it. This is our approach, subject to further systematization using a qualitative analysis. 30 mining engineering students participated in this study. The design uses an action research methodology where active learning activities are implemented and a subsequent evaluation in course satisfaction. The course, the activities, and the evaluation instrument are in Spanish. In this contribution, we present translated results from the activities and instruments.

The detailed process for developing the action research methodology in designing the course is presented below.

### *Justification of the research problem*

A meeting was held with teachers, the management team, and the association of Mining Civil Engineering students, where the necessary contents in the college degree are analyzed and updated. In this context, the AutoCad course is put forward as a vocational training elective course, which is based on the degree curriculum, where within its justifications and objectives, the following profiles are clearly defined:

- Professionals with deep knowledge of their technological environment.
- Professionals committed to the modern, effective use of cutting-edge technologies.

While the graduation profile clearly defines the following:

- Professionals with the skills to create, plan, organize and direct productive mining processes and mining projects in their different stages.
- Professionals are able to work on the engineering design of open pit and underground mining projects.
- Professional able to work in highway construction companies and in hydroelectric projects, in the design of deep excavations and tunnels.

#### *Evaluation instrument*

A Likert-type satisfaction survey was used to evaluate the course. Moreover, the university applied a teacher perception survey to the comprehensive training elective course students.

The instrument focuses on the level of satisfaction in the application of AutoCAD usage activities, analyzing the contribution of the subject to the Earth Sciences activities in parameters such as:

- Role of communication in learning.
- Methodological strategy.
- Communicative relationship.
- Teacher-student relationship attitudes.
- The symmetry of teacher-student relationship.

A general report was prepared to demonstrate category analysis and their respective indicators, a summary table and conclusions are presented.

#### **Program development and course activities**

As the subject syllabus is implemented, activities and evaluations are applied by students in person and online using the "BlackBoard" platform and the "AutoCAD" and "TeamViewer" software.

If students are unable to use University equipment due to VPN failure or other technical difficulties, the capacity to track student AutoCAD download, installation, and activation should be in place as an alternative mechanism.

#### *Remote support*

When students are working online and face technical difficulties, the instructor may use the free-version TeamViewer software to remote control the struggling student's computer and provide support. Students may ask their instructor to access their computer, review the design flaw, and explain to the student the proper steps to be taken. During this process, the students can visualize the failure and the proper use of the Software tools.

## Translation of job commands

It is important to have command tables in both English and Spanish to support the processes. These commands are useful as there are students who have installed the software in a foreign language due to rushing through or lacking experience in download processes.

ESPAÑOL	INGLES	ESPAÑOL	INGLES	ESPAÑOL	INGLES
3D	3d	CALIDADIMG	imagequality	ENLAZARIMG	imageattach
3DARRAY	3darray	CÁMARA	camera	ENLAZARX	xattach
3DCARA	3dface	CAMBIA	change	EQDIST	offset
3DDELIM	3dclip	CAMBPROP	chprop	ESCALA	scale
3DDIST	3ddistance	CAPA	layer	ESCALATI	itscale
3DENCUADRE	3dpan	CAPAP 2002	layerp	ESCALAOLE	olescale
3DMALLA	3dmesh	CARGA	load	ESCENA	scene
3DÓRBITA	3dorbit	CARGADXB	dxbin	ESFERA	sphere
3DÓRBITAC	3dcorbit	CARGAD.XF	dxfin	ESPACIOM	mspace
3DPIVOTAR	3dswivel	CARGAR3DS	3dsin	ESFACIOP	pspace
3DPOL	3dpoly	CARGARMENÚ	menuload	ESTADIST	stats
3DZOOM	3dzoom	CARGARPARCIAL	partialload	ESTADO	status
ABRE	open	CARGAWMF	wmfin	ESTADOARB	treestat
-ABRIRPARCIAL	-partialopen	CERPROP	propertiesclose	ESTILO	style
ACERCA	about	CERRAR	close	ESTILOLM	mstyle
ACISIN	acisin	CERRARDC	adcclose	ESTILOTRAZ	plotstyle
ACISOUT	acisout	CERRAR 2000i	closeall	ESTIRA	stretch
ACOALINEADA	dimaligned	CERREF	refclose	ETRANSMIT 2000i	etransmit
ACOÁNGULO	dimangular	CHAFLÁN	chamfer	EXAMINAR	browser
ACOCENTRO	dimcenter	CILINDRO	cylinder	EXPORTAR	export
ACOCONTINUA	dimcontinue	CÍRCULO	circle	EXTRUSION	extrude
ACOCOORDENADA	dimordinate	COLOR	color	FILTER	filter
ACODIÁMETRO	dimdiameter	COMPILA	compile	FINACTUALIDAD 2000i	endtoday
ACOEDIC	dimedit	CONEXIONBD	dbconnect	FONDO	background
ACOESTIL	dimstyle	CONJREF	refset	FORMA	shape
ACOLINEABASE	dimbaseline	CONO	cone	FORZCURSOR	snap
ACOLINEAL	dimlinear	CONTORNO	boundary	GIRA	rotate
ACORADIO	dimradius	CONVERTAME	ameconvert	GIRA3D	rotate3d
ACOREMPLAZAR	dimoverride	CONVERTCTB 2002	convertctb	GRADÚA	measure
ACOTA y ACOTA I	dim y diml	CONVERTIR	convert	GROSORLIN	lweight
ACOTARR	qdim	CONVESTITOTRAZ 2002	convertpstyles	GRUPO	group
ACOTEDIC	dimtedit	COPIA	copy	GUARDAR	save
ACTUALIDAD 2000i	today	COPIAENLACE	copylink	GUARDARCOMO	saveas

Figure 1. Spanish to English commands.

## Activity Description

Different individual and/or group activities are carried out during class activities using commands taught at the beginning of the class, used together with commands taught in previous classes. The working team analyzes designs to be developed during group activities, sharing their development strategies.

Arising out of general class activities, students are given activities to be performed during the week. However, if students have difficulties finishing these activities in class, the teacher will send on, after class, a step-by-step guide of examples seen in class. An example of an activity is in the appendix.

Figure 2 shows the process of an activity. At the beginning of the course, but also during each activity class, there is time to interact with the software explaining the different commands students will be using in the activity. There is time for interaction in the whole group where the activity is explained and questions are answered. Following, we implement small groups where students interact to solve the activity. The instructor is available to interact with students the rest of the class and during in-office hours. We use TeamViewer if the interaction has to be such that the instructor takes control of the student's computer.

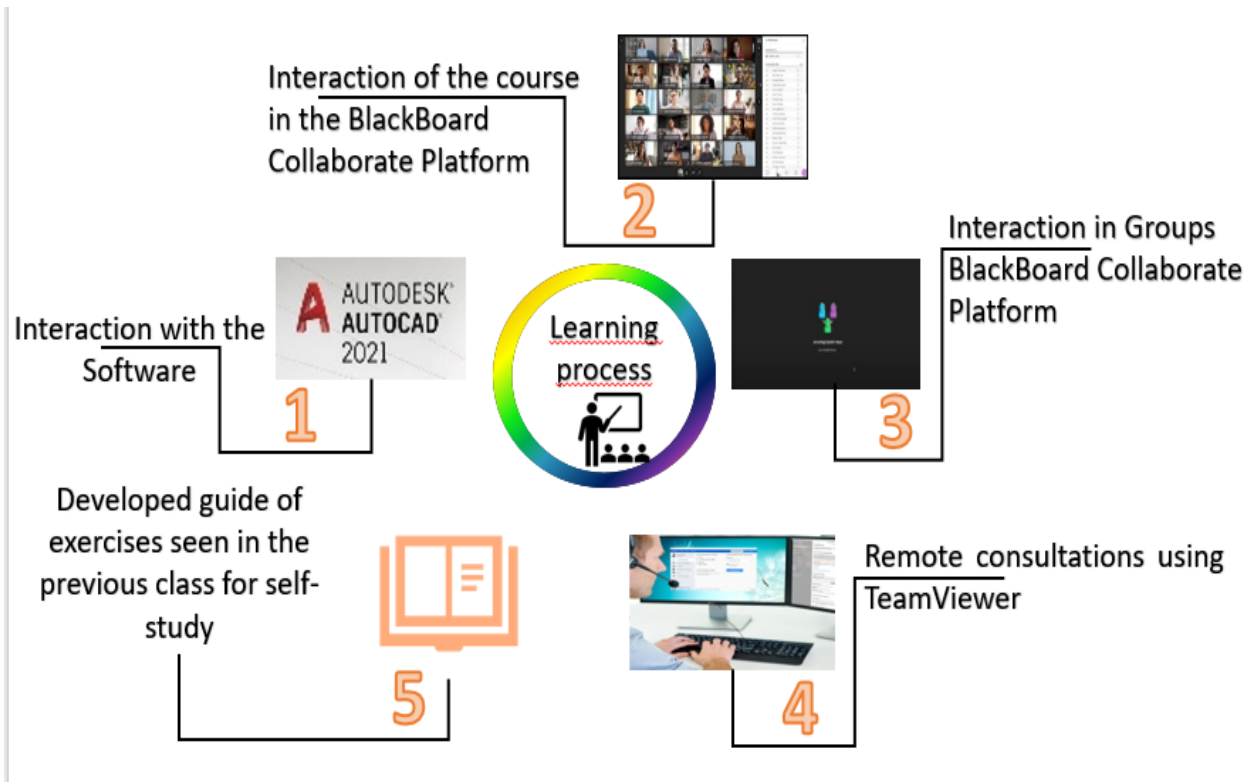


Figure 2. Example of a step-by-step guide for a class activity.

## Results

The change from traditional methods to a more active methodology is considered an important step for students surveyed, a sample of opinions are shown in figure 3.



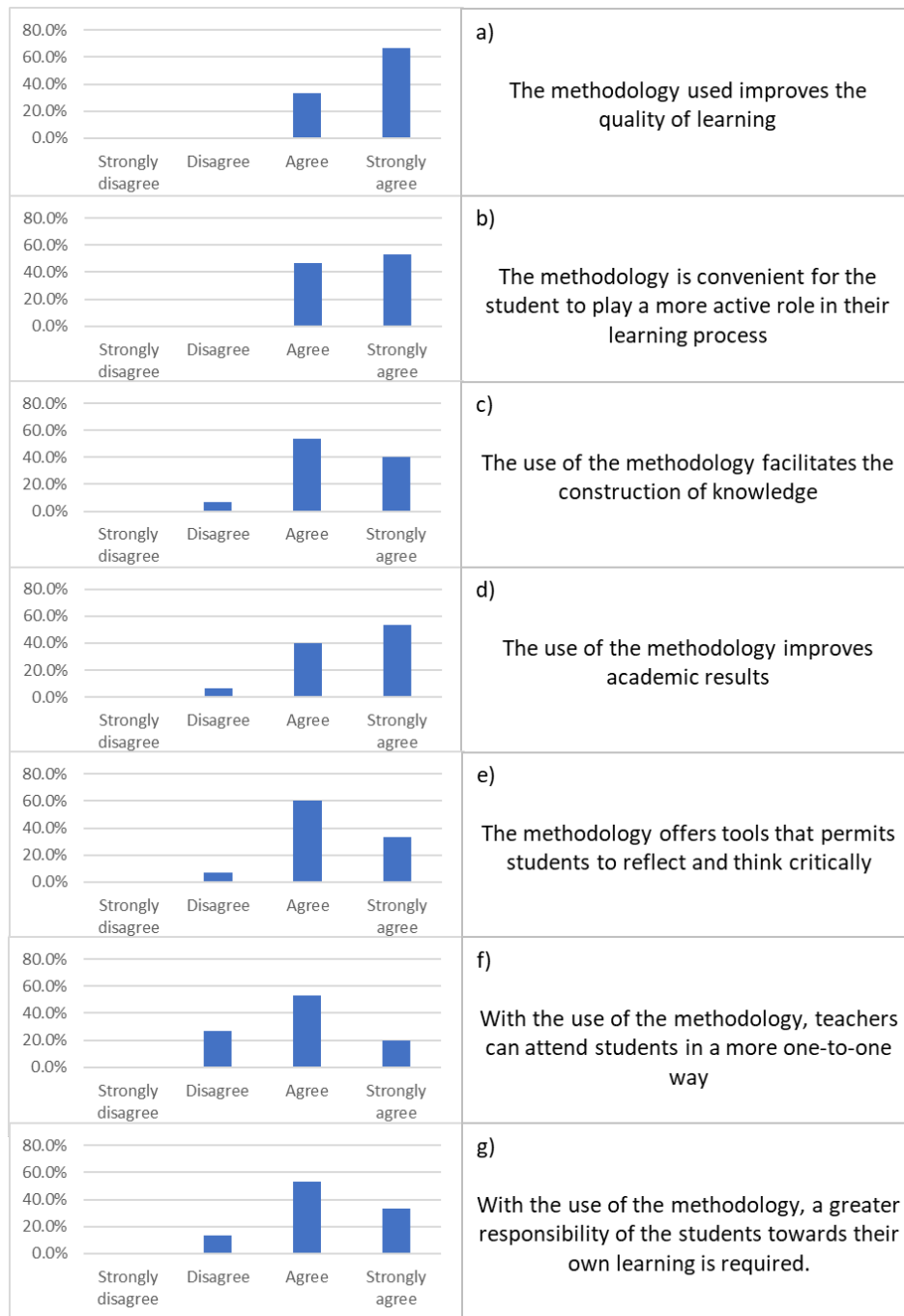


Figure 3. Results of the student satisfaction survey regarding the teaching methodology.

Figure 3 a) shows that a third of students agree, while two-thirds mention "strongly agree" with changing from traditional methodologies towards more active teaching processes. It should be noted that no student disagrees with the learning process used in the course.

Figure 3 b) shows that the course method used is highly valued as a tool for students to play a more active role in their learning process. Students consider it necessary, with 46.7% responding in

agreement and 53.3% mentioning being strongly in agreement. It should be noted that no student disagrees with performing a more active learning role in the course.

Figure 3 c) shows that the use of course methodology is highly valued as a tool that facilitates the construction of knowledge by students. Students agreeing with this statement are 53.3%, while 40.0% mention being strongly in agreement. There are, however, opposing opinions from 6.7% of students, meaning there are areas of opportunity.

Figure 3 d) shows that course methodology is highly valued as a tool that improves student academic results, as 40.0% of students are in agreement and 53.3% are in strong agreement. However, there are contrary opinions from 6.7% of students.

Figure 3 e) shows that the use of the course methodology is highly valued as a tool, eliciting reflection and the use of critical thinking by students, as 60.0% of students mention being in agreement and 33.3% strongly agree. However, there are indeed contrary opinions with 6.7% of students.

Figure 3 f) shows that the use of course methodology is well valued as a tool that gives rise to more personalized student attention, as 53.3% of students mention they agree and 20.0% strongly agree. However, there are contrary opinions, with 26.7% of students in disagreement.

Figure 3 g) shows that the methodology is highly valued as a tool offering greater opportunities for students to manage their own learning, as 53.3% of students agree with this and 33.3% strongly agree. However, there are indeed contrary opinions in 13.3% of students.

The survey reveals that students have an excellent overall opinion. The most favorable mentions are seen in figures a) and b). These two items are described in such a way that the student understands that it is positive for them (figure 3 a) and that their role in class is to learn by doing (figure 3b), unlike other courses where they only listen to the teacher. The first one has to do with the compelling need for mining engineers to train in experiential work, and perhaps the students may have seen this course as an opportunity to do so.

Figure 3 d) has particularly good results, although there are students who do not agree with the notion that it improves academic results. The teacher's experience indicates that results were better than expected in this course, so, perhaps not for all, but for the majority, their academic results improved even if they had taken this course without the use of AutoCAD.

On the other hand, the two items where results offer greater areas of opportunity are in figure 3f) and figure 3g). Item 3f) refers to personalized attention, one-to-one with the teacher. Not all students agreed that this actually occurred. Beyond the pedagogical methodology, this result may be due to the teacher-student relationship. That is to say, it may have been the case that students did not feel comfortable approaching the teacher, and the teacher did not realize that they may have left the students with no interaction. Item 3g) on the other hand, bears relation with the notion that active learning serves shifts learning responsibilities to the student. However, some students disagreed. The result may indeed be affected by the resistance students exhibit at the beginning of any student-centered learning methodology, just because they are habituated to the teacher "teaching".

In addition to the evaluations here presented, the Academic University Vice-Rector office also applied a student perception survey, where a 100% recommendation level was achieved, indicating student satisfaction with their experience.

## **Conclusion**

An AutoCAD elective course was designed for managing and applying said software in earth sciences degrees, based on a collaborative process between directors, academic secretaries, teachers of shared subjects, and students. A program was developed from a syllabus out of which activities were generated in AutoCAD for integrating contents in line with the agreed goals of the graduation profile.

An assessment instrument is applied to mine engineering students in the AutoCAD course. The results of which are reported below:

- The reception seen from students in the use of AutoCAD as a tool to support design activities in mines, tunnels, ramps, frameworks, plants, and three-dimensional modeling of deposits, is very favorable. Given the above, it can be concluded that students achieve greater professional development by administering this type of tool, proving to be fundamental in handling support tools and allocating more time to evaluate solutions to the profession's primary activities.
- There is a lack of formal training in technical skills in the degree, and a gap in the necessary digital literacy is seen in students. Therefore, it is important that active methodologies and the use of tools that contribute to the educational process of students in other courses be recognized since students show a high motivation towards the integration and use of online tools.
- The use of this methodology facilitates managing and building knowledge among students, improves the perception of learning quality, and encourages critical and reflective thinking.
- The use and integration of ICT in the educational process lead to improved academic results, producing greater assimilation of key concepts through the "learning by doing" methodology.
- This methodology improves how they work, facilitates and broadens their points of view, opens up their technical knowledge, and allows greater interaction with their classmates and the teacher. When carrying out real projects, it provides solid support in performing their work.
- The use of the software and the personal search for solutions to the problems raised are validated, requesting support, when necessary, but respecting their own pace of learning.

## *Projections*

Regarding the amount of teaching work to be done in developing the methodological process and learning tools, it can be concluded that the task is quite arduous for the instructor. The results are dependent on instructor orientation, willingness to clarify questions and demonstrate to students how to manage the program. Activities should facilitate the process by designing activities that may facilitate deeper knowledge assimilation. Therefore, it can be concluded that the experience an instructor has in the software is relevant in generating practical strategies that may be followed at the pace of each student within the times' frameworks of the class.

Given the design of this course, presenting other specific courses using software to be integrated into the academic structure of earth science careers is projected.

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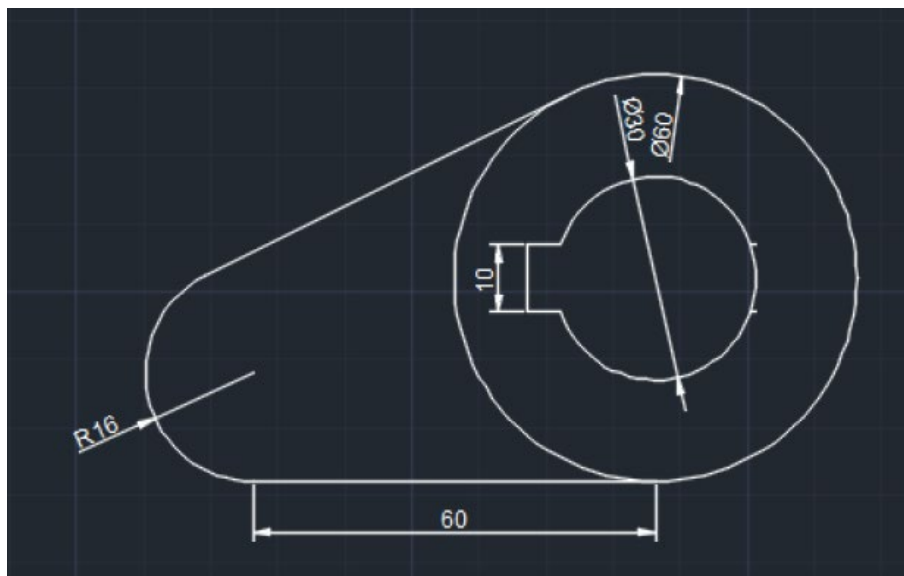
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## Appendix

Developed exercise - AutoCad

Exercise that will be carried out step by step using the basic drawing and editing commands.



## SOLUTION

Step 01 Verify that Object Snap (F3) and Ortho Mode (F8) are active.

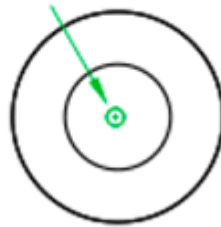


Step 02 Right click on the Object Snap button on the status bar and verify that the Endpoint, Center, Quadrant and Intersection options are active.

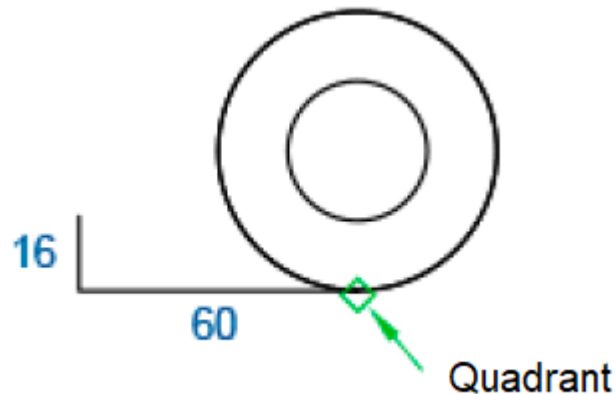
Step 03 Activate the CIRCLE command: Type C and Enter. Specify center point for circle: Click on any point. Specify radius of circle: type D and Enter. Specify diameter of circle: type 30 and Enter.

Step 04 Activate the CIRCLE command: Type C and Enter. Specify center point for circle: Click on the center of the circle. Specify radius of circle: type D and Enter. Specify diameter of circle: type 60 and Enter.

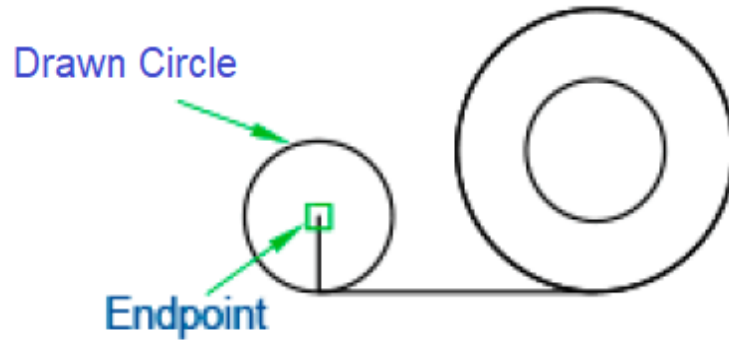
### Center of the Circle



Step 05 Activate the LINE command: type L and Enter. Specify first point: Click on the lower Quadrant of the 60 diameter circle. Specify next point: Move the pointer to the left, type 60 and Enter. Specify next point: move the pointer up, type 16 and Enter. Specify next point: Enter to end the command.

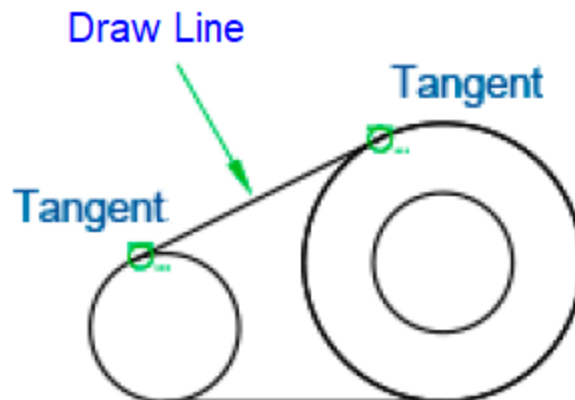


Step 06 Activate the CIRCLE command: Type C and Enter. Specify center point for circle: click on the upper endpoint of the line of 16. Specify radius of circle: type 16 and Enter.

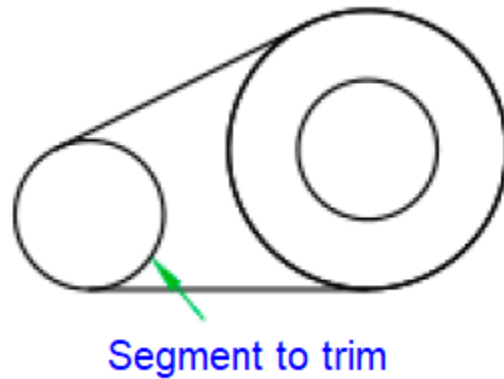


Step 07 Select line 16 and press DELETE key to delete it.

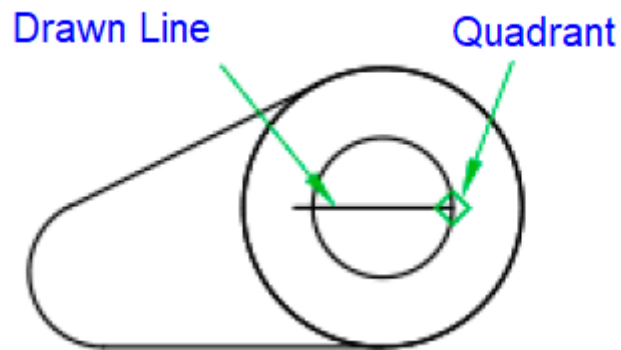
Step 08 Activate the LINE command: type L and Enter. Specify first point: press and hold Shift, then right-click anywhere on the screen, release Shift, select the Tangent option, click on the top right of the circle of radius 16. Specify next point: press the Shift key and hold it down, then right-click anywhere on the screen, release the Shift key, select the Tangent option, click on the top left of the 60 diameter circle. Specify next point: Enter to finish the command.



Step 09 Activate the TRIM command: type TR and Enter. Select objects: Enter. Select object to trim: Click on the circle segment you want to trim. Select object to trim: Enter to finish command.



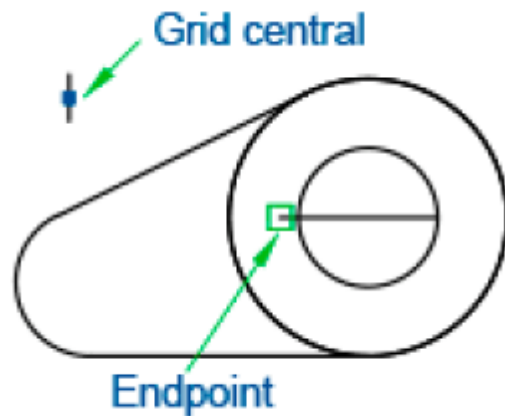
Step 10 Activate the LINE command: type L and Enter. Specify first point: click on the right Quadrant of the circle of diameter 30. Specify next point: move the pointer to the left, type 34 and Enter. Specify next point: Enter to end the command.



Step 11 Activate the LINE command: type L and Enter. Specify first point: Click on a point on the screen, move the pointer down, type 10 and Enter. Specify next point: Enter to end the command.

Step 12 Select the drawn line by clicking on it, 3 blue boxes named GRIP will be displayed Click on the center grip Move the pointer and click on the Left Endpoint of the line of 34. Press the ESC key to remove the selection.



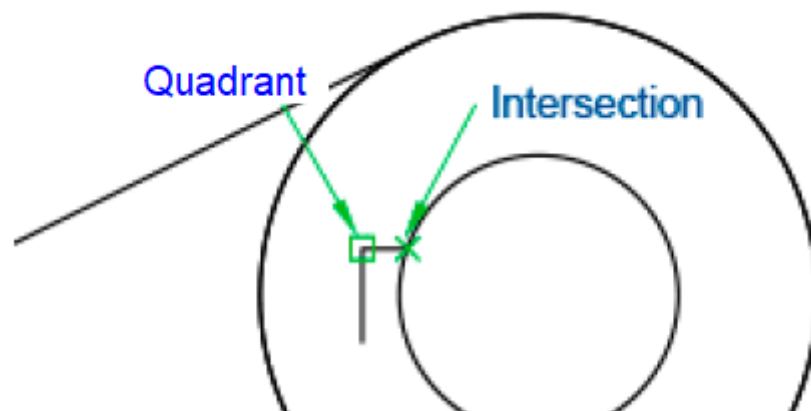


Step 13 Select line 34 and press the DEL key to delete it.

Step 14 Press F10 to activate Polar Tracking mode.

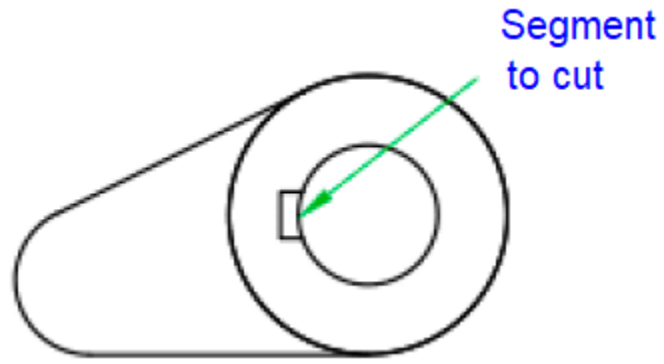
step 15

Activate the LINE command: type L and Enter. Specify first point: click on the upper Endpoint of the line of 10. Specify next point: move the pointer to the right horizontally until the point of intersection with the circle of diameter 30 appears and click. Specify next point: Enter to end the command.



Step 16 Activate the LINE command: type L and Enter. Specify first point: Click the bottom Endpoint of the line of 10. Specify next point: Move the pointer to the right horizontally until the point of intersection with the circle of diameter 30 appears and click. Specify next point: Enter to end the command.

Step 17 Activate the TRIM command: type TR and Enter. Select objects: Enter. Select object to trim: click on the segment of the circle that you want to trim. Select object to trim: Enter to finish command.



Completed exercise