


APPLICATION OF REVIT SOFTWARE TO IMPROVE SPATIAL INTELLIGENCE IN ARCHITECTURE STUDENTS IN A PRIVATE UNIVERSITY – HUANCAYO

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ARTICLE INFO	ABSTRACT
<p>Article history:</p> <p>Received 30 June 2023</p> <p>Accepted 28 September 2023</p>	<p>Objective: To determine the effect of the application of the Revit program in the improvement of spatial intelligence in Architecture students in a private university in Huancayo-Peru.</p> <p>Theoretical structure: Armstrong (2006) expressed that spatial intelligence refers specifically to the content of forming a mental model in the spatial world and to control, act using this pattern, in an aggregate of attitudes and skills that combine a subtle understanding in shapes, lines, color, dimensions and spaces and the relationship of elements, which in turn allows largely to visualize and graphically represent a spatial or visual idea, mostly involves the improvement of visual perception. As stated by Rossado (2017) students use manual graphic expression to convey ideas quickly, and in the future, they should be able to combine the use of technology and manual expression, in addition to allowing students to express their design project anytime and anywhere, this will give them fluid cooperation, communication, empathy, cooperation, respect, ethics, honesty and teamwork skills, all of which provide adaptability to any work situation.</p> <p>Design/Methodology/Approach: The study was conducted through a quantitative approach, according to Hernandez et al. (2014) is quasi-experimental which will be composed of two groups, the control and experimental, which will receive the treatment or stimulus, it is of longitudinal cut will collect the results of the studies that are conducted by collecting data at a single time and with the execution of the post test allows us to measure the effect of the program on spatial intelligence.</p> <p>Conclusions: Differences of ranges of spatial intelligence have been observed between the control and experimental group; the value of Z was found below the critical value $Z_c = -1.96$ where $(-6.137 < -1.96)$ and the $p = 0.000 < 0.05$; with such result it can be affirmed that by using the Revit program a significant impact in the improvement of spatial intelligence is achieved, therefore the H_0 is rejected and H_a is admitted.</p> <p>Originality/Value: The present study is a significant contribution because it postulates the results obtained through field work and whose statistical treatments allow understanding the importance of the development of special intelligence in university students of the professional career of architecture in the consolidation of technical skills and management of technological applications such as Revit.</p> <p>Doi: https://doi.org/10.26668/businessreview/2023.v8i10.3882</p>
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APLICAÇÃO DE SOFTWARE REVIT PARA MELHORAR A INTELIGÊNCIA ESPACIAL EM ESTUDANTES DE ARQUITETURA EM UMA UNIVERSIDADE PRIVADA - HUANCAYO

RESUMO

Objetivo: Determinar o efeito da aplicação do programa Revit na melhoria da inteligência espacial em estudantes de Arquitetura em uma universidade privada em Huancayo-Peru.

Estrutura teórica: Armstrong (2006) expressou que a inteligência espacial refere-se especificamente ao conteúdo da formação de um modelo mental no mundo espacial e para controlar, agir usando este padrão, em um agregado de atitudes e habilidades que combinam uma compreensão sutil em formas, linhas, cores, dimensões e espaços e a relação de elementos, que por sua vez permite em grande parte visualizar e representar graficamente uma ideia espacial ou visual, principalmente envolve a melhoria da percepção visual. Como afirmado por Rossado (2017) os alunos usam a expressão gráfica manual para transmitir ideias rapidamente, e no futuro, eles devem ser capazes de combinar o uso da tecnologia e a expressão manual, além de permitir que os alunos expressem seu projeto de design a qualquer hora e em qualquer lugar, isso lhes dará cooperação fluida, comunicação, empatia, cooperação, respeito, ética, honestidade e habilidades de trabalho em equipe, todas as quais fornecem adaptabilidade a qualquer situação de trabalho.

Design/Methodologia/Abordagem: O estudo foi realizado através de uma abordagem quantitativa, de acordo com Hernandez et al. (2014) é quase experimental, que será composta por dois grupos, o controle e experimental, que receberá o tratamento ou estímulo, é de corte longitudinal irá coletar os resultados dos estudos que são realizados através da coleta de dados em um único momento e com a execução do pós-teste permite-nos medir o efeito do programa sobre a inteligência espacial.

Conclusões: Diferenças de intervalos de inteligência espacial foram observadas entre o grupo de controle e experimental; o valor de Z foi encontrado abaixo do valor crítico $Z_c = -1,96$ onde $(-6,137 < -1,96)$ e $p = 0,000 < 0,05$; com tal resultado, pode-se afirmar que usando o programa Revit um impacto significativo na melhoria da inteligência espacial é alcançado, portanto, o H_0 é rejeitado e H_a é admitido.

Originalidade/Valor: O presente estudo é uma contribuição significativa porque postula os resultados obtidos através do trabalho de campo e cujos tratamentos estatísticos permitem compreender a importância do desenvolvimento de inteligência espacial em estudantes universitários da carreira profissional de arquitetura na consolidação de habilidades técnicas e gestão de aplicações tecnológicas como o Revit.

Palavras-chave: Arquitetura, Projeto, Inteligência Espacial, Visão Espacial, Revit.

APLICACIÓN DEL SOFTWARE REVIT PARA MEJORAR LA INTELIGENCIA ESPACIAL EN ESTUDIANTES DE ARQUITECTURA DE UNA UNIVERSIDAD PRIVADA - HUANCAYO

RESUMEN

Objetivo: Determinar el efecto de la aplicación del programa Revit en el mejoramiento de la inteligencia espacial en estudiantes de Arquitectura de una universidad privada de Huancayo-Perú.

Estructura teórica: Armstrong (2006) expresó que la inteligencia espacial se refiere específicamente al contenido de formar un modelo mental en el mundo espacial y controlar, actuar usando este patrón, en un agregado de actitudes y habilidades que combinan una comprensión sutil en formas, líneas, color, dimensiones y espacios y la relación de elementos, lo que a su vez permite en gran medida visualizar y representar gráficamente una idea espacial o visual, principalmente implica la mejora de la percepción visual. Como afirma Rossado (2017) los estudiantes utilizan la expresión gráfica manual para transmitir ideas rápidamente, y en el futuro, deben ser capaces de combinar el uso de la tecnología y la expresión manual, además de permitir a los estudiantes expresar su proyecto de diseño en cualquier momento y en cualquier lugar, esto les dará cooperación fluida, comunicación, empatía, cooperación, respeto, ética, honestidad y habilidades de trabajo en equipo, todo lo cual proporciona adaptabilidad a cualquier situación laboral.

Diseño/Methodología/Enfoque: El estudio se realizó a través de un enfoque cuantitativo, según Hernández et al. (2014) es cuasi-experimental el cual estará compuesto por dos grupos, el control y el experimental, el cual recibirá el tratamiento o estímulo, es de corte longitudinal se recogerán los resultados de los estudios que se realicen mediante la recolección de datos en un solo momento y con la ejecución del post test nos permite medir el efecto del programa sobre la inteligencia espacial.

Conclusiones: Se han observado diferencias de rangos de inteligencia espacial entre el grupo control y experimental; el valor de Z se encontró por debajo del valor crítico $Z_c = -1,96$ donde $(-6,137 < -1,96)$ y el $p = 0,000 < 0,05$; con tal resultado se puede afirmar que al utilizar el programa Revit se logra un impacto significativo en la mejora de la inteligencia espacial, por lo tanto se rechaza el H_0 y se admite H_a .

Originalidad/Valor: El presente estudio es un aporte significativo porque postula los resultados obtenidos a través del trabajo de campo y cuyos tratamientos estadísticos permiten comprender la importancia del desarrollo de

inteligencia especial en estudiantes universitarios de la carrera profesional de arquitectura en la consolidación de habilidades técnicas y gestión de aplicaciones tecnológicas como Revit.

Palabras clave: Arquitectura, Diseño, Inteligencia Espacial, Visión Espacial, Revit.

INTRODUCTION

The use of software applications in society has become more important in current times due to technological advances; therefore, Santiváñez (2021) stated that university education currently faces new challenges that generate changes in society as an important factor for development. Likewise, the World Bank (1999) stated that higher education has a transcendental role in laying the solid foundations of human capital and thus contributing to the development of countries based on a competent and productive workforce that allows the implementation of new ideas and technologies.

At the international level, in Spain, Angulo (2020), showed that the use of modeling software helps to create and manipulate mental images in a very simple and intuitive way and to develop their spatial vision, in turn responds to the students' own demands, generating the use of technology also for other disciplines, and to interact with the information in two-dimensional and three-dimensional form generating changes in the educational proposal. Likewise, in Indonesia, Suprpto et al. (2018) demonstrated that spatial intelligence is an activity that helps university students to develop creativity, the study that was conducted allowed to diagnose and develop spatial ability, and its capabilities, which were used as a learning strategy. Along the same line, Morales & Del Cerro (2017) presented a study that focused around a didactic unit related to the research axis in the curricular area of graphic expression to improve spatial ability, detailing how innovations have been made in working with linked content, the perspectives of objects with augmented reality tools.

At the national level, according to MINEDU in Law No. 28044, higher education aims at a solid holistic foundation of university students, promoting research and innovation and thus form professionals of the highest level in society contributing to the development and growth of the country within the university education system, as well as the implementation of programs that complement the inventiveness, support creativity and promote innovative activities in various areas of knowledge. Likewise, trying in students to develop better spatial capabilities. Gómez (2019) designed through descriptive geometry with the support of three-dimensional models, a project achieving with such study important progress, alluding that

education should consider these courses with graphic representations including digitization as effective learning tools.

At the national level, according to MINENU in Law No. 28044, higher education aims at a solid holistic foundation of university students, promoting research and innovation and in this way to train professionals of the highest level in society contributing to the development and growth of the country within the university education system, as well as the implementation of programs that complement inventiveness, support creativity and promote innovative activities in the various areas of knowledge. Likewise, trying in students to develop better spatial capabilities. Gómez (2019) designed through descriptive geometry with the support of three-dimensional models, a project achieving with such study important progress, alluding that education considers these courses with graphic representations including digitization as effective learning tools.

Locally, at the private University of Huancayo, after having observed that, although teachers are using tools to improve spatial intelligence in their pedagogical practice, despite this, there is a scarce use of technological modeling resources in the practice of architecture students, this possibly responds to the lack and experience in the use of Revit software, and main resources that favors modeling and the development of spatial intelligence in its aspects such as: the relations between the spatial intelligence and the spatial intelligence in its aspects such as: spatial relationships, spatial vision and graphic representation, which benefits the students' learning. Another important aspect is the inadequate use of software by students in the laboratories, generating loss of time in not identifying the programs used in architecture, the processing capacity of computers and the types of evaluation by the teacher in the laboratory. All teachers should be committed to take the best educational strategies that facilitate improvements in spatial intelligence in architecture students, therefore, it is essential to conduct research, as well as the interest to improve the proposals that enhance the practice in the professional training of architecture students.

Thus, the problem to be studied is: What is the effect of the application of the Revit program in the improvement of spatial intelligence in architecture students? And as specific problems: What is the effect of the application of the Revit program in the improvement of spatial relationships, spatial vision and graphic representation in architecture students in a private university in Huancayo-Peru?

The general objective will be; To determine the effect of the application of the Revit program in the improvement of spatial intelligence in students of Architecture in a private

university of Huancayo-Peru; The general objectives will be; To determine the effect of the application of the Revit program in the improvement of spatial intelligence in Architecture students in a private university of Huancayo-Peru; and as specific objectives, To determine the effect of the application of the Revit program in the improvement of the dimension of spatial relationships, spatial vision and graphic representation in Architecture students in a private university of Huancayo-Peru.

The general hypothesis is that the application of the Revit program will significantly influence the improvement of spatial intelligence in Architecture students in a private university in Huancayo-Peru. And the specific hypotheses: The application of the Revit program will significantly influence the development of spatial relationships, spatial vision and graphic representation in Architecture students in a private university in Huancayo-Peru.

LITERATURE REVIEW

In Villar (2021) research, he obtained an $r= 0.379$, between Spatial Intelligence and collaborative learning, unlike the variable of spatial relationships ($r=0.542$), spatial vision ($r=0.437$) and graphic representation ($r= 0.320$); Achieving significance between the variables, using quantitative methods, the size of the population sample was 82 individuals; concluded that collaborative learning contributed positively and significantly to the optimization of spatial intelligence in students. Likewise, Cadenillas (2020) worked on the measurement of Spatial Intelligence, taking as a principle that the teaching of engineering drawing disciplines is based on the use of design as the main tool. The sample was made up of 55 students from the faculties of engineering and architecture, the results were satisfactory and significant.

It is also noted that Gómez (2019) determined how to improve spatial skills when teaching the subject of Geometric Description supported by 3D models. The results of this study measured the spatial ability of 216 students. And a slight improvement of 22% was observed in spatial skills, and the findings suggest that non-direct training of learners in spatial skills using geometry lessons and digital augmentation can be an effective educational tool. Likewise, Altuna (2019), proposed to determine the influence of using 3D programs when teaching isometric drawing of solids and debugging, obtaining as results of a quasi-experimental research, and the application of two groups, pretest and posttest in the management of software, obtaining a p -value <0.05 , generating a significant difference with the 3D software application; It was concluded that the application of these programs positively increases student learning.

On the other hand, Vela (2019), studied the influence of Revit on spatial intelligence, in a research with 54 students, divided into control and experimental groups, testing the hypothesis, using Student's "t", where $\alpha=0.000$ as a result, in independent tests; concluding that students, when using drawing software, thus improve their imagination, creativity and spatial decisions, significantly influencing the teaching strategy of teachers.

Likewise, Maquera (2019), studied the relationships between multiple intelligences and academic performance in students from Puno, in addition to concluding that spatial intelligence and other intelligences that a student can develop, worked with 115 students and obtained a positive and significant correlation ($r=0.623$, $p=0.000<0.05$); concluded that there was a direct and significant association between the variables with the academic performance generated in the applied evaluations. Along these same lines, Ventura (2017) developed a quasi-experimental research whose purpose was to know if DIGRAFIP was a learning optimization tool, allowing causal inferences between the variables. Regarding the study group, it was represented by 23 students. It was concluded that software is important for improving spatial intelligence in terms of focus, concentration and creativity, and it also allows students with simple shapes to acquire spatial skills.

On the international stage, Senderos et al. (2022) developed a work experience with the use of a modeling tool that allows students to develop new skills without forgetting the traditional representations used for graphing, seeking articulation with both tools, with the method of axonometry and perspective generating that students develop spatial skills, understanding, interpretation and graphic representation of architectural space, introducing BIM technology through software for modeling in two-dimensional and three-dimensional forms. Likewise, Villar (2021) demonstrated that there is a significant relationship with the practice of Revit software with collaborative learning in architecture students, carrying out a correlational research ($r=0.320$; $p<0.05$), with a sample of 82 individuals, which is related to the present investigation since its sample is made up of university students in the area of drawing, and they also belong to the faculty of architecture.

On the other hand, Angulo (2020) in his educational innovation project aimed to improve the capacity for spatial vision using 3D modeling software as a tool; who obtained as a result that 3D modeling software helps to create mental images in a very simple and intuitive way in a Spanish context, at the same time it is related to the studies carried out by authors cited in their research, which mentions the importance of 3D software , helps increase spatial

awareness, from this we conclude that 3D modeling software helps create these mental images in a very simple way and allows you to manipulate them at your own pace.

For its part, Zabaleta (2018) aimed to design an intervention proposal to develop spatial capacity for “spatial vision” students as a way to motivate learning with augmented reality in Spanish students, as a result it managed to reduce the gap in current education in modeling that exists between traditionally used methods and new digital environments in a time ten times less than the time with a traditional drawing in a comparison to the control group, reaching speed in graphic representation using software; concludes by affirming and validating that 3D modeling software such as the use of the Revit program, in modeling a home, students can visualize the facilities in their real form, understand them as a whole and interact actively and dynamically with the content during the presentation.

Similarly, Tristancho (2019) demonstrated that drawing design is based on the ability to mentally manipulate objects and ideas, to apply in a design process, in students at the University of Colombia; thus achieving results that show how computer tools and modeling programs allow the learning curve to significantly increase and enhance the spatial ability of the learners, 18% excellent, at the beginning and at the end of the course the group of control increases to 37% in excellent, concluding that when design and software workshops are implemented, a better learning curve was obtained in terms of the quality of graphic presentation and the speed that is reduced to ten times compared to a traditional drawing , generating a very significant impact.

Likewise, Vega (2018) used strategic planning for implementation in the faculty of primary education, which allowed improving the teacher's performance in pedagogical practice, with the spatial relationship, vision and scheme, where the entire process started from the organization and planning in the teaching of students in the area of arts, through applied research, of the descriptive and correlational type, demonstrating the lack of educational experience on the part of teachers who do not consider the development of spatial intelligence as a priority , its educational planning, concluding in turn show the lack of educational experiences and the importance of spatial intelligence in the Peruvian educational system.

On the other hand, Villa (2017) , proposed activities for the development of Spatial Intelligence through graphic representation in students of the Polytechnic University of Catalonia, who obtained as a result the strategy in spatial logistics, data analytics and spatial analytics, generated in an initial pretest and posttest and a “T” test where 67% of students improved their spatial abilities, from this it is concluded that when comparing the initial and

final results of the activities they generate an impact on the educational strategies, and the relevance of the spatial skills for the work success of young people and particularly in architecture and it is undeniable to enhance educational systems to achieve educational objectives.

From the above, it can be stated that the resources that contribute to the development of spatial intelligence, such as spatial relationship, spatial vision and representation, are of great importance.

For Saorín (2006) the spatial relationship is a tool for pedagogical work, which allows our students to perform two-dimensional and three-dimensional rotations, in which they actively participate in real time, facilitating the orientation work of the students. and evaluation by teachers.

On the other hand, Arrieta (2006) argued that like spatial perception, another alternative is when the objective of recognizing objects with three-dimensional shapes and volumes is applied, folding and unfolding their faces, it is achieved that users can create images and conserve the ideas created in the mind, likewise you can visualize in real time what the vision of an object is.

Likewise, Vitruvio (1997) made reference to graphic representation, a tool that had its origin in the art of mastering drawing, so that through graphic reproduction or sketching, students can visualize the work they intend to make, allowing the teacher to evaluate the result in real time and can also be focused with different drawing techniques, an advantageous situation to achieve security, usefulness and beauty in the students' work.

Finally, the use of these tools has its application in different graphic representation techniques that promote learning, as well as through the use of software, such as AutoCAD, which is used for essential computer design. Among the programs we have Revit, which allows modeling, creating, sketching and perceiving a project model in different formats, so those involved in the implementation of a certain project work together regardless of the place or time, generating collaborative work in real time, facilitating work, in two-dimensional and three-dimensional formats, generating a realistic vision with greater precision and control over the construction elements, and this has gained great importance in the industry of architecture in recent years due to its great advantages.

Likewise, Martínez (2017) developed a work experience on the sketch of a home with the use of the Revit program software, generating a global spatial vision where students increased their spatial awareness and learning through inquiry by alternating with the

presentation of traditional content of expression generating an increase in the information and application of the program, improving participatory learning, thus articulating traditional representation and the use of programs. Similarly, Hermes & Rodríguez (2017) proposed re-studying and accrediting how the technical drawing subject is taught for university students, with AutoCAD, based on learning strategies and techniques for teaching articulated with technical drawing, based on new procedures. methodological. In conclusion, it demonstrates the effectiveness of the proposal in the quality of teaching by articulating these two methodologies. Likewise, Vela (2019) stands out, who after applying his instruments in the experimental group, concluded that students who use modeling programs improve their imagination and that Revit has a beneficial impact when taken as a didactic strategy since the program It allows you to capture building models in two/three dimensions, track, move complete construction objects and create interior and exterior views of said objects, who use the software thus improve their imagination, creativity and improvisation in both form and function.

As can be seen, the use of modeling software becomes an important tool in the evolution of the Spatial Intelligence of university students, who together with those responsible for the relevant chairs incorporate all knowledge to contextualize the activities within the university educational system, as well as same the implementation of programs that complement creativity and innovation in a holistic way. While educators need to learn new teaching strategies that allow them to develop skills and abilities in teaching spatial intelligence, Sánchez (2017) argued that it is important to generate changes in traditional teaching to focus on optimizing capabilities, skills and competence. of the students to choose the analysis of the organization and to use and glimpse the knowledge taught and in this way train new future professionals trained at the service of society.

Another aspect is that man does not live in a two-dimensional form but in a three-dimensional environment, which is why it is important for the architecture student to adapt to society when interacting and encouraging how he represents through drawing programs. where you can show your creativity since your professional training depends on spatial intelligence and the way you make your graphs to solve problems, creating and showing your ideas, sketches and presentations in different courses and then developing them professionally through throughout your life at the same time considering that technology is fashionable and architecture is no stranger to these changes of innovation that technology brings, optimizing

time and resources during the development of your projects and having great demand for the uses of software. in all areas.

However, Armstrong (2006) expressed that spatial intelligence refers specifically to the content of forming a mental model in the spatial world and controlling, acting using this pattern, in an aggregate of attitudes and skills that combine subtle understanding in ways, lines, color, dimensions and spaces and the relationship of elements, which in turn largely allows visualizing and graphically representing a spatial or visual idea, mostly involves the improvement of visual perception, although Mamani (2014) stated that it is also important, that the lack of vision does not mean that spatial intelligence has not been developed, this intelligence requires three-dimensional thinking of shapes, representation from different angles that allows you to recognize a character by its shape, regardless of the angle of vision.

Likewise, architecture students generate learning through competence and skills which allows them to perform in professional life, as Rossado (2017) stated, students use manual graphic expression to transmit ideas quickly, and in the future they should be able to combine the use of technology and manual expression, in addition to allowing students to express their design project anytime and anywhere, this will give them fluid cooperation, communication, empathy, cooperation, respect, ethics, honesty and the ability to work as a team, all of which provides adaptability to any work situation.

Likewise, Colmenar et al. (2014), demonstrated that augmented reality allows us to solve the spatial lack, they are tools that are currently part of education, generating virtual objects in three dimensions, which allows the possibility of interacting and reinforcing spatial intelligence for resolution, analysis and interpretation of drawing elements in both 2D/3D, generating skills for students with poor spatial vision.

On the issue of dimensions, Saorín (2006) stated that it was enough to notice the differences, interpreting the changes in the images. Likewise, Vásquez & Noriega (2011) mentioned that spatial perception referred to the ability to find a horizontal line, orient yourself, and find a reference to it. Spatial perception tasks propose using the center of gravity, in which case skills that use gravitational and kinesthetic cues, rather than purely visual indices, are the most successful. Spatial rotation refers to the content of mentally rotating two-dimensional and/or three-dimensional bodies as devices, and imagining two-dimensional or three-dimensional shapes of an element in different places quickly and accurately.

Regarding spatial vision, Saorín (2006) maintained that it occurs when there is a communication of size, proportion and scale between the parts of that whole or set. When it is

possible to perceive sufficient connections between the diverse elements, the transcendent analytical skill that allows learning and being able to detect problems is developed; Proportion is also essential, because it gives the object presented the precise balance. And connecting the parts of a whole, in the dimension of their projections, is considered a graphic projection of an object to the figure obtained on a surface by a set of lines called projection lines.

On the other hand, Zevi (1953) mentioned that until the discovery and use of perspective, it could be observed that an artistic painting represented the space in each work and a realistic image of what was seen, where reality was seen and observed all the days, in different circumstances, sizes, and proportions. In its dimension of graphic representation, an architect must master the art of drawing so that through graphic reproduction he can visualize the work he intends to create. In this sense, geometry also provides multiple aids to architecture, since it facilitates the practice of using rules and compasses, where building designs are easily reflected in plots through the placement of lines, planes and squares.

MATERIAL AND METHODOLOGY

Type of Research

Hernandez et al. (2014) The paradigm of this research is positivist, hypothetical-deductive method; It is applied to provide solutions to specific situations or problems.

Design of Research

Quantitative approach, according to Hernández et al. (2014), it is quasi-experimental which will be composed of two groups, the control group and the experimental one, which will receive the treatment or stimulus, it is longitudinal section will collect the results of the studies carried out with the data collection in a single moment and with the execution of the post test it allows us to measure the effect of the program on spatial intelligence.

Variables and Operationalization

Conceptual definition: revit program application

Information of a three-dimensional digital model that can be used for the effective management of a project, Revit is a program that provides facilities for making sketches, which allow an architectural object to be analyzed from all angles, each level, each view is a presentation of information from the same database, working in the drawing view of the underlying building model, Revit coordinates reports automatically by making changes to

model views, floor plans, sections and dimensional information on three-dimensional drawing sheets, and programming models simultaneously.

Operational definition: revit program application

The variable of the application of the Revit program will be measured by the Workshops in the class session, considering the structure of the program.

Conceptual definition: spatial intelligence

For Armstrong (2006) it is the individual's ability to mentally visualize in 3D including the personal management of collecting, manipulating and making changes in configurations of infinite and finite space.

Operational definition: spatial intelligence

The variable spatial intelligence is measured by the Spatial Intelligence Questionnaire, with 20 items that considers the dimensions of spatial relationships, made up of 7 items of application and spatial vision, through 8 items, graphic representation will contain 5 items.

Population, Sample and Survey

Population

Chawla & Sodhi (2011) maintained that the population represents the total of observations with similar peculiarities, which for the present investigation has been made up of 150 students.

Sample

The sample will be the population that will be made up of architecture students who are in their fourth cycle.

Table 1. Investigation groups

Group	Section	N
Control Group	A1	25
Experimental Group	B1	25

Source: Prepared by authors (2023)

Sampling

Convenience sampling has been used as it is the most appropriate in the analysis.

Data Collection Techniques and Instruments

Bavaresco (2013) maintained that methods are the path to confirmation of the problem proposition. The survey technique has been applied with different questions that make up the pre-coded questionnaire, and its necessary tool in the configuration of behavior and knowledge of spatial intelligence, for which the pedagogical test will be used (Pre and post test).

Instrument validity

For Salkind & Bruce (2021) it is the quality of a mechanism to accurately and rigorously measure or calculate what it is intended to find out. For this, three expert teachers have been used, postgraduate with a Master's or Doctorate degree for the respective validation, the same ones who received the appropriate information to be able to issue an adequate judgment.

Instrument confidence

Reliability coefficient was measured by Cronbach's alpha, whose value was 0.778. The instrument was the dichotomous questionnaire on spatial intelligence before and after, the application of the instrument will be associated with the graphic expression class.

Procedure

The corresponding permission was requested from the entity and the pertinent information was collected at the beginning of the 2023-1 academic year in an academic two-month period (two months), both groups were initially evaluated and after the evaluation, the strategies and workshops were applied. stimulus, through which the effect caused was measured, the completion of the survey took an average of 20 to 25 minutes.

Data analysis method

In compiling the information, the data was managed in the Excel program, and in SPSS V27, descriptive statistics were carried out, in tables and frequencies. Subsequently, the inferential study was carried out, using the Mann-Whitney test after checking for normality.

Ethical aspects

The application of the principles of benevolence, autonomy, justice and non-abuse becomes fundamental in experimental studies with people. The principle of autonomy, which is also called respect for them, is based on the fact that each person has the capacity of their

individual actions to determine their own standard independently, they have the freedom to choose, applying their reasoning and having analyzed the negative and positive aspects, decide what behavior you want to follow. (i) Principles of autonomy: according to Sarangi (2011), it refers to the participant's decision-making, since they must be respected and promoted as an object of research (the corresponding permissions were requested). Informed consent. (ii) Principle of beneficence: According to Raymond et al. (2018) refers to acting benevolently and anticipating or nullifying harm. (iii) Principles of maleficence: The authors Acharya et al. (2021) the principle refers to the fact that there is an obligation to reduce the risk of harm, the research is anonymous, without violating the privacy of the respondents. (iv) Principle of justice: according to Faizan & Bhat (2019), it is referred to as its functional expression in research ethics in not discriminating when selecting research subjects. Everyone has been treated equally, there was no preferential treatment, everything was cordial and respectful.

RESULTS AND DISCUSSION

Table 2. Contingency table of Spatial Intelligence according to perception groups

		Architecture Students at a Private University			Total
		Control group (Posttest)	Experimental group (Posttest)		
Spatial intelligence	Low	Count	1	0	1
		% of the total	2.0%	0.0%	2.0%
	Regular	Count	24	18	42
		% of the total	48.0%	36.0%	84.0%
	Well	Count	0	7	7
		% of the total	0.0%	14.0%	14.0%
Total	Count	25	25	50	
	% of the total	50.0%	50.0%	100.0%	

Source: Prepared by authors (2023)

There are significant differences in spatial intelligence, where 2.0% of the sample concerning the control group considers that the variable is at a bad level, while no member of the experimental group perceives it as bad; The results reflect that when applying the Revit program, spatial intelligence improves or influences students, since there is 48.0% of the control group that considers spatial intelligence as regular, while 36.0% of the control group after applying the Revit program places it on the same level; Finally, no participant in the control group considers that spatial intelligence is at a good level, while when applying the program in the experimental group, 14.0% perceive it as good.

Inferential Results

Proceeding with the Man-Whitney U test after analysis of normality.

General Hypothesis

Ho: The application of the Revit program will not significantly influence the improvement of Spatial Intelligence in Architecture students.

Ha: The application of the Revit program will significantly influence the improvement of Spatial Intelligence in Architecture students.

Table 3. Ranges of spatial intelligence

		Ranks		
Architecture Students		N	average R.	Summation
Spatial intelligence (Posttest)	Group Control	25	13.06	326.50
	Group Experimental	25	37.94	948.50
	Total	50		

Source: Prepared by authors (2023)

It was observed that there could be significant disparities in the perception of spatial intelligence between the control and experimental groups, since there is a variability of 622.00

Table 4. Test statistic

Architecture Students (Posttest)	
Mann-Whitney U	150,000
Wilcoxon W	326,500
Z	-6,137
asymptotic sig. (bilateral)	,000

Source: Prepared by authors (2023)

In relation to the results, differences in ranges were observed between the groups of perception of spatial intelligence between the control and experimental groups; the Z value was found below the critical value $Z_c = -1.96$ where $(-6.137 < -1.96)$ and $p=0.000 < 0.05$; With this result it can be stated that by using the Revit program a significant impact is achieved in the improvement of spatial intelligence, which is why H_0 is rejected and H_a is admitted .

Specific hypothesis 1

Ho: The application of the Revit program will not significantly influence the development of spatial relationships in Architecture students.

H1: The application of the Revit program will significantly influence the development of spatial relationships in Architecture students.

Table 5. Ranges of spatial relationships

Architecture Students	N	Ranks	
		average R.	Summation
Spatial Group Control	25	17.82	445.50
relation Group Experimental	25	33.18	829.50
(Posttest)Total	50		

Source: Prepared by authors (2023)

It has been observed that there could be significant disparities in the spatial relations dimension of spatial intelligence between the control and experimental groups in architecture students at a Private University - Huancayo, since there is a variability of 384.00

Table 6. Test statistic

	Architecture Students (Posttest)
Mann-Whitney U	120,500
Wilcoxon W	456,500
Z	-3,881
asymptotic sig. (bilateral)	,000

Source: Prepared by authors (2023)

Differences in ranges have been observed between groups in the perception of spatial relationships between the control and experimental groups; Likewise, a Z is displayed below the critical value $Z_c = -1.96$ where $(-3.881 < -1.96)$ and $p=0.000 < 0.05$; With this result, it can be stated that the employability of Revit will have a significant impact on the improvement of spatial relationships, which is why H_0 is rejected and H_1 is admitted.

Specific hypothesis 2

Ho: The application of the Revit program will not significantly influence the development of spatial vision in Architecture students.

H2: The application of the Revit program will significantly influence the development of spatial vision in Architecture students.

Table 7. Ranges of spatial vision

Architecture Students	N	Ranks	
		average R.	Summation
Spatial Group Control	25	18.32	458.00
vision Group Experimental	25	32.68	817.00
(Posttest)Total	50		

Source: Prepared by authors (2023)

It has been observed that there could be important disparities in the spatial vision dimension of the variable spatial intelligence of the control and experimental group in architecture students, since there is a variability of 359.00

Table 8. Test statistic

	Architecture Students (Posttest)
Mann-Whitney U	133,000
Wilcoxon W	458,000
Z	-3,665
asymptotic sig. (bilateral)	,000

Source: Prepared by authors (2023)

It has been observed that there are differences in ranges between the spatial vision perception groups of the control and experimental groups; Likewise, the Z value is established below the critical value $Z_c = -1.96$ where $(-3.655 < -1.96)$ and $p=0.000 < 0.05$; With this result it can be stated that the application of the Revit program will produce a significant impact on the development of the students' spatial vision, rejecting H_0 and accepting H_2 .

Specific hypothesis 3

H_0 : The application of the Revit program will not significantly influence the development of graphic representation in Architecture students.

H_3 : The application of the Revit program will significantly influence the development of graphic representation in Architecture students.

Table 9. Ranges of graphic representation

	Architecture Students	Ranks		
		N	average	R.Summation
Graphic representation (Posttest)	Group Control	25	16.44	411.00
	Group Experimental	25	34.56	864.00
	Total	50		

Source: Prepared by authors (2023)

It has been observed that there could be significant disparities in the graphic representation dimension of spatial intelligence between the control and experimental groups in architecture students, since there is a variability of 453.00

Table 10. Test statistic

	Architecture Students (Posttest)
Mann-Whitney U	86,000
Wilcoxon W	411,000
Z	-4,614
asymptotic sig. (bilateral)	,000

Source: Prepared by authors (2023)

In relation to the results, it is observed that there are differences in ranges between the groups in the perception of graphic representation between the control and experimental groups; Likewise, the value of $Z < Z_c = -1.96$ where $(-4.614 < -1.96)$ and $p=0.000 < 0.05$; With this result, it can be stated that the application of the Revit program will have a significant impact on the development of graphic representation in Architecture students, 2022, rejecting H_0 and admitting H_3 .

CONCLUSION

Differences in spatial intelligence ranges have been observed between the control and experimental groups; the Z value was found below the critical value $Z_c = -1.96$ where $(-6.137 < -1.96)$ and $p=0.000 < 0.05$; With this result it can be stated that by using the Revit program a significant impact is achieved in the improvement of spatial intelligence, which is why H_0 is rejected and H_a is admitted.

There were differences in ranges between the groups in the perception of spatial relationships between the students of the control and experimental groups; Likewise, a $Z < Z_c = -1.96$ is displayed where $(-3.881 < -1.96)$ and $p=0.000 < 0.05$; With this result, it can be stated that the employability of Revit will have a significant impact on the improvement of spatial relationships, which is why H_0 is rejected and H_1 is admitted.

Differences in ranges between the spatial vision perception groups were found between the students in the control and experimental groups; and the Z value is set below the critical value $Z_c = -1.96$ where $(-3.655 < -1.96)$ and $p=0.000 < 0.05$; With this result it can be stated that the application of the Revit program will produce a significant impact on the development of the students' spatial vision, rejecting H_0 and accepting H_2 .

Differences in ranges were found between groups in the perception of graphic representation between the group of students in the control and experimental groups; Likewise, the value of $Z < Z_c = -1.96$ where $(-4.614 < -1.96)$ and $p=0.000 < 0.05$; With this result, it can be stated that the application of the Revit program will have a significant impact on the

development of graphic representation in Architecture students, 2022, rejecting H_0 and admitting H_3 .

RECOMMENDATION

It is recommended that university institutions implement Revit application laboratories to enhance the capabilities of architecture students and develop their professional skills in the search for better solutions in architectural projects and train university teachers in the management of automated teaching resources in order to raise the level of academic development. Finally, it is suggested to carry out future research based on the results obtained in the present investigation and expand the field of scientific and technological knowledge.

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