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AUDIOVISUAL RESOURCES IN IMPROVING THE ACADEMIC PERFORMANCE OF ENGINEERING STUDENTS

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KEYWORDS

Audiovisual distribution
Audiovisual learning
Learning process
Instant messaging
Mobile devices
Hybrid laboratory

ABSTRACT

This article analyzes audiovisual resources to improve learning and grades of engineering students. For this purpose, the flipped class methodology has been applied in the laboratory of the Hydraulic Works subject of three educational institutions with different geopolitical environments. The approach reveals that the experimental group presents an improvement in the acquisition of competences, satisfaction and exam grade compared to the students of the control group. It is concluded that the audiovisual resources promote greater skill and confidence in students, which has a positive impact on academic performance

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1. Introduction

In the last decades, due to the technological development and accentuated by the COVID-19 pandemic process, there is a high tendency to apply Audiovisual Communication in the education sector due to its strengths. In this context, several universities have validated the development of media such as television, cinematography, videoconferencing, virtual platforms, QR codes, streaming platforms and social networks as useful methodologies for the development and process of teaching and learning (Cartes-Barroso, 2022; De La Torre & Díaz-Luc, 2023; Lorenzo, 2022).. For example, social networks in young people is a current and future trend that can be used as a tool from the proper use to strengthen skills in information management, storytelling, creative process to innovation and social protagonism. (Martín-Romo & Belinchón, 2022).. On the other hand, the mobile device has been transformed from a technology to a lifestyle medium that seeks to document everyday realism through audio recordings, videos and images published online.

In particular, videos allow capturing those elements of non-verbal communication that are not expressed in lecture notes, such as physical effects of flows in open channels. Secondly, digital images or photographs as an educational potential are the result of multiple forms of visual expression that show objective evidence (Piemontese, 2021). In this regard, Guerra (2022); Howard (2022) point out that audiovisual media are tools that allow promoting social inclusion, reducing feelings of insecurity and eliminating marginalized groups. In addition, the author points out that it develops a greater capacity and experience to communicate solutions to social problems.

Therefore, audiovisual resources are a proposed solution for the assurance of students' academic performance, university educational quality and scientific development. (Silva-Hernández, 2023). In this sense, Salazar-Palomino et al. (2024) applied a survey to 1240 students in which they demonstrated by means of factorial analysis the preference for hybrid learning with ample use of audiovisual resources. On the other hand, Paterson et al., (2020) emphasize that the multimodal feedback distribution method in combination with face-to-face classes, online classes, audios and recorded videos promotes academic performance. As demonstrated by Máñez et al. (2024) in 175 university students, who prefer video feedback compared to written feedback as a medium more accessible to the social environment. Remaycuna-Vasquez et al. (2024) in studies based on audiovisual resources in a sample of 287 university students detect in their surveys on perception and academic performance a positive correlation that favors greater performance in academic activities.

However, there is still a need to strengthen technologies and the digital environment for their effectiveness in the context of higher education. (Cartes-Barroso, 2022). Indeed, advances in information and communication technologies (ICT) drive new learning models in the university (Melo & Sánchez, 2017). In particular, the flipped classroom is a new strategy that allows interrelating audiovisual media in teaching and learning between educators and students. This model seems to be appropriate for engineering education due to a combination of increasingly heterogeneous hybrid models in the audiovisual marketplace (Dehghan et al., 2022; Karabulut-Ilgu et al., 2018).The application of the model allows students to transfer study theories at home as a self-learning oriented process. Independent or group study is done by students through videos, image and texts. Therefore, more time is spent on dynamic problem solving in the classroom (Cabi, 2018).

In Mozambique, higher education implements pedagogical innovations such as migration from conventional classrooms to digital classrooms, considering that the population presents basic, social, economic and regulatory difficulties by the government. Rhongo & da Piedade (2022) demonstrated, from a questionnaire to 164 teachers from 15 Higher Education Institutions in Mozambique, that there are basic obstacles such as technological resources, audiovisual media and Internet connectivity, only 83% use the digital classroom to manage and deliver online content.

In Cuba, a broad audiovisual and differentiated conception has been implemented in the national education system, covering all educational levels starting with television programming on the Educational Channel (Karla et al., 2017; Werthein, 1976).. However, little research has been found on the performance of students as a result of the use of audiovisual resources. The fundamental causes are due to the low diversity of the technological park, access and speed of internet, as well as payment rate, compared to other developing countries (Williams, 2022).

In Peruvian Higher Education, there are multiple scientific evidences of the use of audiovisual media in education. In this regard, Caramutti De La Piedra & Ibáñez (2022); Del Savio et al. (2023); Salazar-

Palomino et al. (2024) have shown that students improve competency development and learning. In addition, they cite that there is effectiveness of audiovisual media in performance and deep and lasting learning over time on students. However, there is little research focused on civil engineering.

Students in the civil engineering career use multiple mechanisms and forms of expression of the problems to achieve the results. A common aspect is the computer laboratories and physical laboratories that frequently present doubts and concerns when executing the models. In other instances, inconsistency in the test procedure, forgetting the content, lack of clear ideas, omission of important data and confusing conclusions, all of which have repercussions on low academic performance. A particular case is the hydraulics laboratories, where, in addition to the problems raised, the student has difficulty with measuring equipment and hydraulic connections. Consequently, there is an insufficient number of students motivated by the activity. The traditional model has been focused on an explanation and delivery of the test guide by the teacher, but there is an immediate need to generate changes to improve learning. Therefore, the purpose of the study is to propose the use of audiovisual resources in the inverted classroom to improve student performance in grades.

2. Materials and Methods

2.1 Context of the subject

The research was developed in collaboration with three universities from different countries, Instituto Superior Politécnico de Gaza (ISPG) in Mozambique; Universidad de Ciego de Ávila (UNICA), Cuba and Universidad Católica Sedes Sapientiae (UCSS), Lima, Peru in the year 2023. It was framed in the laboratory of the subject of Hydraulic Works of the Civil Engineering career, with the exception of the Higher Polytechnic Institute of Gaza that was in the career of Hydraulic, Agricultural and Rural Water Engineering, but in the same context of the study plan and lessons learned. Hereinafter, only the countries where the research was carried out will be mentioned.

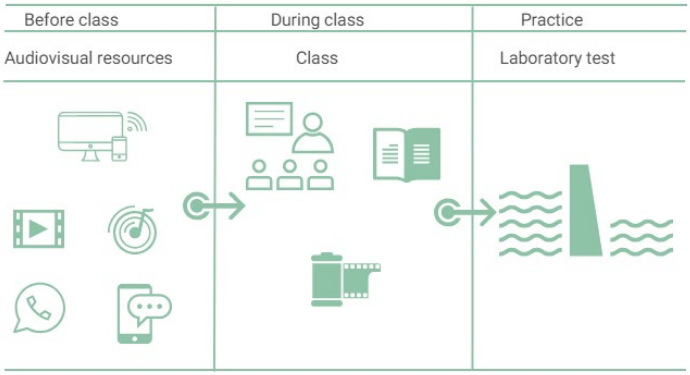
The inverted classroom activity was with audiovisual resources designed for one of the four laboratory sessions. In particular, section four, consisted of the evaluation of the scale model of the dam spillway from physical and numerical aspects. Therefore, the technologies and means were identical for the homologation of the instrument. The course 2023-1 was conceived as a control group in the Hydraulic Works laboratory of 71, 79, 77 students, while, the experimental group was registered 77, 74 and 80 students from the University of Mozambique, Cuba and Peru respectively.

In the laboratory sections, it was ensured that they were taught by the same professors for a total of 8 specialists. In addition, it was ensured that the professors had a similar level of experience in higher education and knowledge of audiovisual resources. In this regard, the professors used the same material and audiovisual tools (videos, images, electronic mini-books) with previous planning according to the laboratory activity. In order to pass the course, students must satisfactorily complete all the laboratories.

2.2 Laboratory through audiovisual resources

In course 2023-2, defined as the experimental group, the didactic approach of laboratory 4 was modified to an inverted classroom section by means of audiovisual resources. As a result of the doubts, uncertainties and inaccuracies on the part of the students to use the physical instruments, measurements and calibrations. The number of students was 20 per section and grouped in teams of 4 members. Audiovisual files, videos.mp4; image.jpg; image.gif; texts.pdf and texts.ppt, were shared in the virtual classroom with the students of the experimental group 2023-2 two days before the activity. A WhatsApp group administered by the teacher was also developed to share the audiovisual media. However, prior to the lab 4 section, the teacher requested that students watch the short 8-minute video sent to the WhatsApp group, in addition to the explanation of the objectives and procedures at the beginning of the lab. The video consisted of the professor's explanation of concepts and demonstration of how to perform the experimental procedure, data collection and processing. Figure 1 shows the flow of activities of the experimental group. Two weeks after the laboratory, students were tested with the same open-ended questions as in 2023-1 to measure learning and academic performance.

Figure 1. Flow of activities of the experimental group



Source: Own elaboration, 2024.

2.2 Traditional laboratory

The traditional approach was carried out during the 2023-1 course defined as the control group. As with the inverted classroom laboratory, the number of students was 20 per section and grouped in teams of 4 members. However, with this traditional model, the students were only given the practical laboratory guide and the explanation of the experimental concepts and procedures at the beginning of the section. In addition, students were tested two weeks after the laboratory with open-ended questions to verify learning objectives and academic performance.

2.3. Objectives of this research

Three specific objectives were evaluated. First, to check the satisfaction of students using audiovisual resources through the inverted classroom. Secondly, to determine student academic performance and thirdly, to contrast if there is a difference in academic performance, through the laboratory delivery models.

For the evaluation of the objectives it was initially necessary to use a questionnaire for the students that contemplated the category of satisfaction in the laboratory with the audiovisual media through the inverted classroom. A questionnaire was used based on the one presented by Remaycuna-Vasquez et al. (2024); Río-Gamero et al. (2022); Vicente et al. (2022) but with 9 items categorized into Factor 1, Factor 2 and Factor 3, as shown in Table 1. Factor 1, aimed at the benefit of the classroom invested through audiovisual resources which are Q4, Q8, Q9. Factor 2 to collaboration and communication, which covered Q3, Q5, Q6. Finally, Factor 3 the use of video, images and digital texts, which covered Q1, Q2, Q7. While, the questionnaire was analyzed by the Likert Scale.

Table 1. Student satisfaction questionnaire in the laboratory.

items	Questions
Q1	Does the content of the audiovisual resources provide accurate information for the development of the laboratory?
Q2	Do you consider it essential to watch the videos, images and digital texts prior to the laboratory practice?
Q3	Do you consider that the inverted classroom favors communication and collaboration among your classmates in relation to the traditional laboratory?
Q4	Do you feel motivated to perform the lab with audiovisual resources in relation to the "traditional" labs?
Q5	Does the inverted classroom make it easier to express your doubts and opinions in the lab session?
Q6	Does the flipped classroom method contribute to developing skills for my professional development?

items	Questions
Q7	What value do you place on audiovisual resources in the flipped classroom for your learning?
Q8	Does the virtual classroom with audiovisual resources contribute to study habits?
Q9	Would you recommend to other students to take courses that include the method of inverted learning with audiovisual resources?

Source: Own elaboration, 2024.

2.4 Performance evaluation method

The students' performance during the internship was evaluated with combined research approach to improve the understanding of the problem. The qualitative assessment was based on cognitive ability. (Shi & Qu, 2022). Where students receive visual and auditory stimuli, including text, images and videos. In particular, the teacher collected the students' feelings during the development of the laboratory with and without inverted classroom; as well as issuing a qualitative assessment of the perception of the activity.

Then, the quantitative research was complemented based on the objective grades of the laboratory practice reports. The laboratory practice report contained 10 questions on concepts, data collection procedures, information processing, interpretation and explanation of results. The report was graded between 0 to 20 points, the evaluation of 0 to 10 points is fail, the minimum evaluation of pass 11 points and maximum 20 points.

2.5 Data processing and analysis

As for the security of the instrument applied, Cronbach's alpha was used with a hierarchical range: excellent $0.8<\alpha \leq 0.9$; good $0.7<\alpha\leq 0.8$; acceptable $0.6 < \alpha \leq 0.7$; poor $0.5<\alpha\leq 0.6$; unacceptable $0.5<\alpha$. The Kolmogorov-Smirnov test was valid to contrast the normality of the information series. On the other hand, to contrast the difference in academic performance through both methods, Spearman's nonparametric test was run. The null hypothesis (Ho) was that, "There is no relationship between academic performance in the 2023-1 and 2023-2 academic years. As an alternative hypothesis (H1), "There is a relationship between academic performance in the 2023-1 and 2023-2 academic years". Thus, it was verified whether there were significant differences between the traditional laboratory and the laboratory with audiovisual media.

3. Results

The result of the reliability of the research is shown in Table 2. Cronbach's alpha indicator shows a value that ranged from 0.846 to 0.895 for factors 1, 2 and 3. Cronbach's alpha proved to be consistent to an excellent hierarchical range of $0.8<\alpha \leq 0.9$ therefore, the questionnaire is shown to be safe for application.

Table 2. Reliability of the instrument

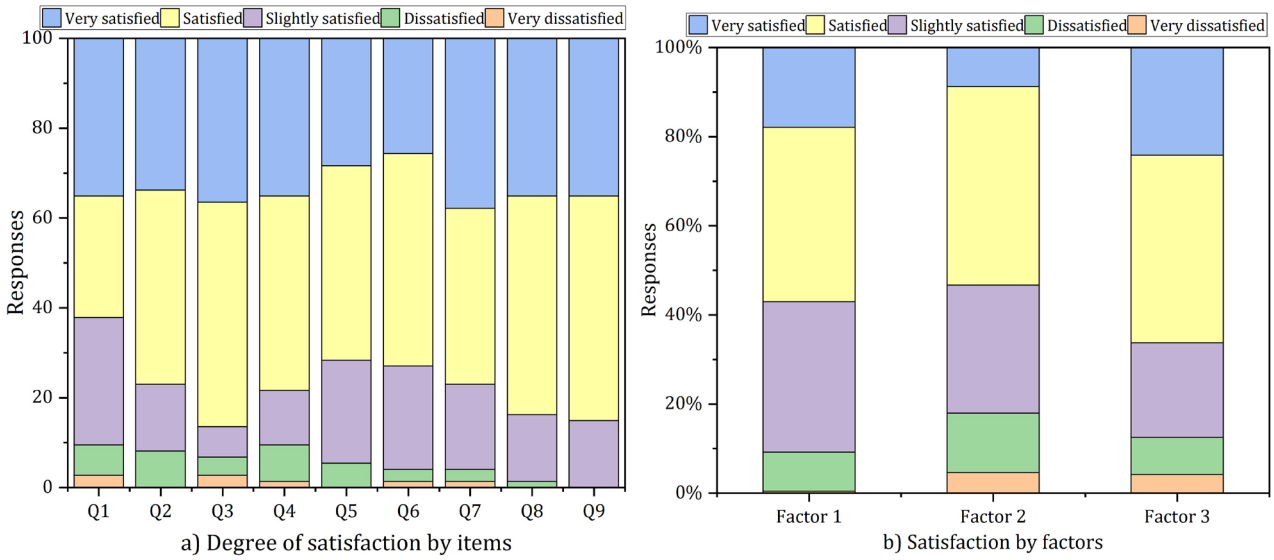
Category	α
Factor 1	0,884
Factor 2	0,846
Factor 3	0,853
Total	0,895

Source: Own elaboration, 2024.

The results of students' satisfaction with the use of audiovisual resources are shown in Figures 2, 3, and 4. In general, the satisfaction of the students of the three universities in the experimental group was

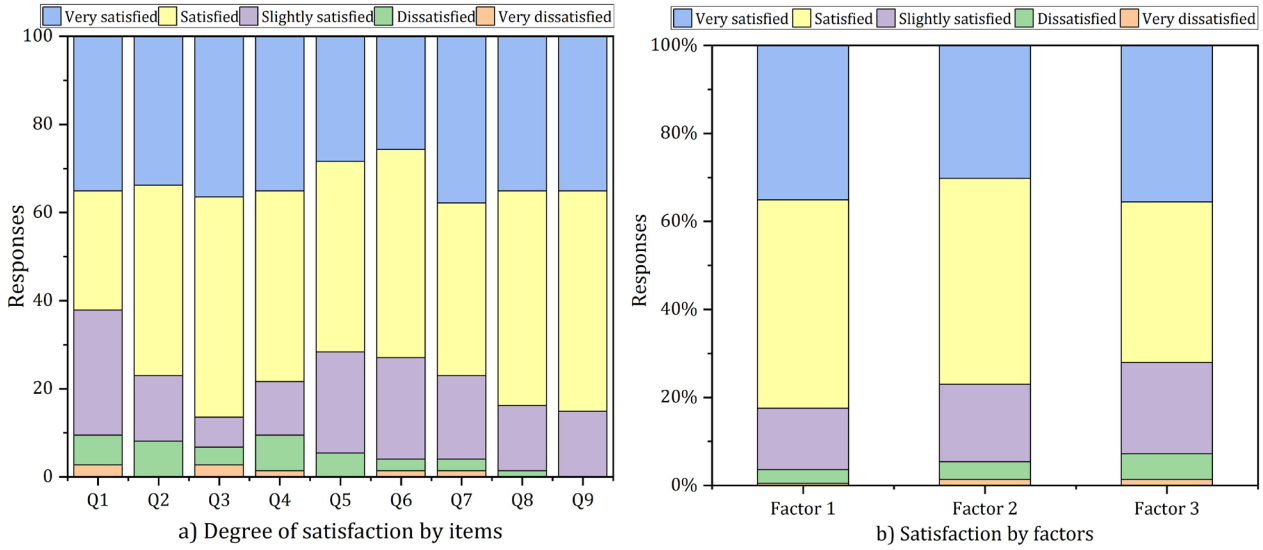
satisfactory. The audiovisual resources videos, images and electronic texts prior to the laboratory section contributed to the developmental and motivating environment of the activity, as well as the use of the virtual classroom and WhatsApp group.

Figure 2. Student satisfaction with the ISPG.



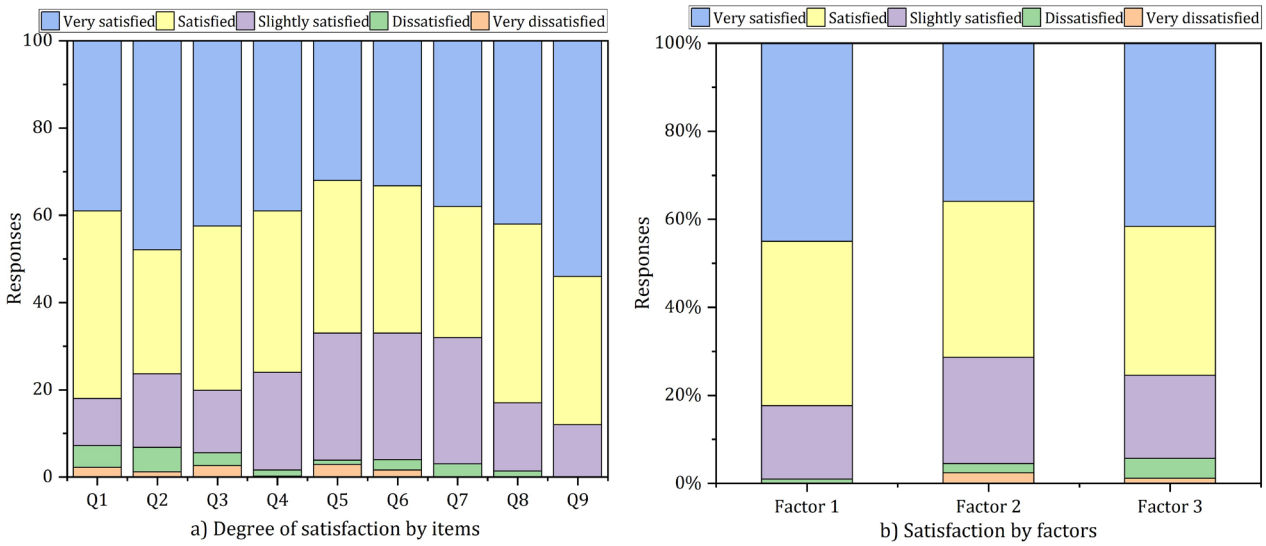
Source: Own elaboration, 2024.

Figure 3. Student Satisfaction at UNICA



Source: Own elaboration, 2024.

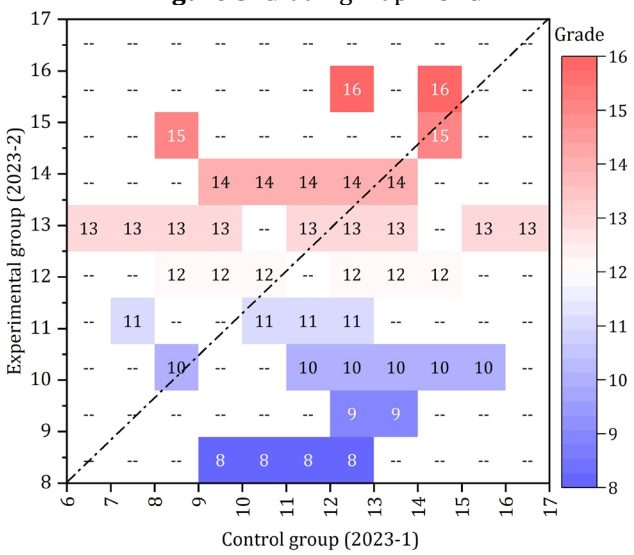
Figure 4. Student Satisfaction in UCSS



Source: Own elaboration, 2024.

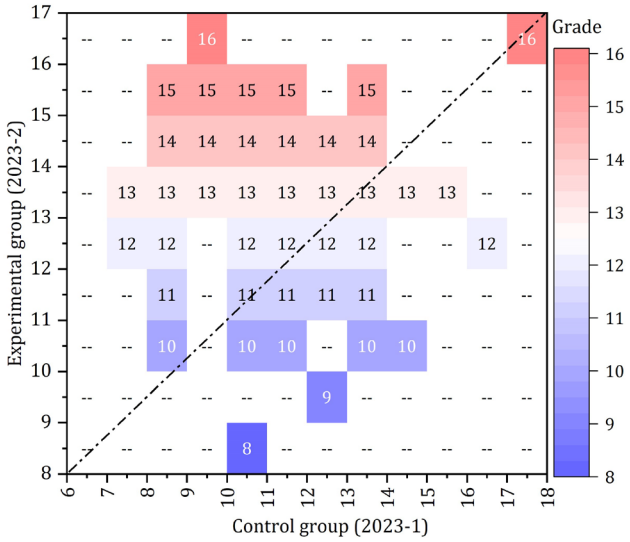
The academic performance of the students was plotted using heat maps in Figure 5, 6 and 7. The red color indicates the highest value and the blue color the lowest, while the value of the box is the number of grades obtained for the range indicated. Likewise, the empty boxes are indicative of no ratings. In general, a better spatial distribution of academic performance is observed in the 2023-2 course compared to the 2023-1 course. In the same context, it follows that there is an improvement in student learning. In contrast, there is a greater tendency for students to fail when audiovisual media are not used.

Figure 5. Grading map - ISPG



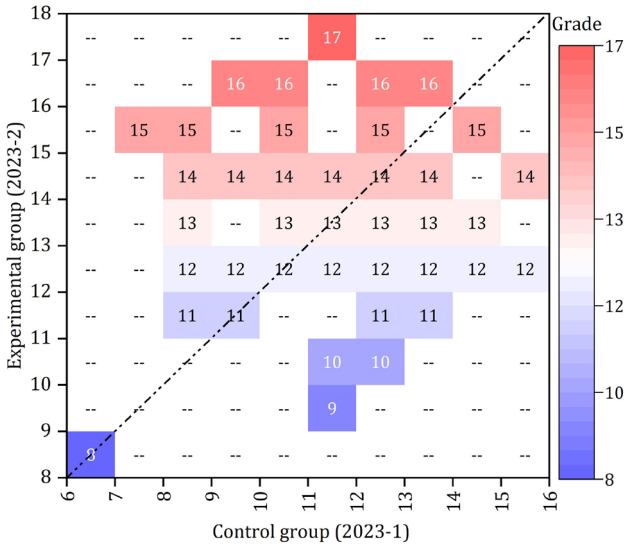
Source: Own elaboration, 2024.

Figure 6. Grading map - UNICA



Source: Own elaboration, 2024.

Figure 7. Grading map - UCSS



Source: Own elaboration, 2024.

4. Debate

The instrument applied according to Cronbach's alpha analysis was found to be at a common threshold of acceptability and reliability. Based on the hierarchical range raised by several authors between 0.7 and 0.8, it is classified as excellent, good or adequate (Taber, 2018). Therefore, the questionnaire intended to measure the dependent variables turned out to be a novel tool because it allowed measuring the students' satisfaction product of the application of the inverted classroom with audiovisual resources.

In relation to factor 1, on the benefits of audiovisual resources the respondents of the experimental group in Mozambique, Cuba and Peru 57%; 82%; 83% rated it as satisfactory to very satisfactory respectively. In particular, none of the students "strongly disagreed" with the consideration that the use of videos will facilitate laboratory skills and learning. In relation to item Q4 and Q9 were the most representative for students with 61% of motivation in relation to traditional laboratories and 62% of students recommending the learning process with audiovisual resources respectively.

Factor 2 integrated the effect of audiovisual resources on collaboration and communication among students, of which 68% distinguished a greater effectiveness in relation to the traditional laboratory. Cuban students reached 77% of greater acceptance in relation to Mozambique with only 53.33%. The

items with the highest incidence were Q3; Q5 with 72% and 65% of satisfaction respectively. In this sense, communication, collaboration, clarification of doubts and opinions before and after was of greater impact in the experimental group.

Factor 3 related to the application of audiovisual resources reached 71.25% of the experimental group. This group indicated that they were satisfied to very satisfied with the laboratory through audiovisual resources. Therefore, it is an indicator that indicates the degree of effectiveness, welcoming and inspiring that the short videos have, prior to the laboratory practice, because it provides them with a group of precise information that facilitates the development of the tests. In particular, the students from the University of Peru reached a degree of satisfaction higher than 75%, those from Cuba 72.1%, while the lowest value was 66.25% in Mozambique. Nevertheless, these were encouraging values for research with repercussions on decision-making for future laboratories. In relation to the item with the highest satisfaction on the part of the students was Q2 with 73%, which makes the understanding of the practical activity a few minutes earlier. Likewise, the teacher was able to explain the laboratory procedures once the section started, which allowed more time to clarify doubts and physical interaction with the measuring equipment. In addition, a more enjoyable environment was created among students for the development of the activity. In general, it can be stated that there was an increase in the satisfaction of students using the laboratories with audiovisual resources through the inverted classroom in relation to students using the traditional laboratory.

In the experimental group, composed of 231 students, 70.81% rated the model between satisfied and very satisfied with the content of the inverted classroom through audiovisual resources. Meanwhile, only 67 students said they were not satisfied or very dissatisfied with the use of audiovisuals. In relation to the educational centers, there were similar results, with 76.45 and 77.2% of acceptance in the surveys of students from Cuba and Peru, respectively. They also stated that they are motivated by visual resources. In comparison with the students of the University of Mozambique, who reached a lower level of 58.9%. Río-Gamero et al. (2022) in their research found that 87% of students were more confident in laboratories that used videos as visual aids compared to traditional ones. These results are a product of students being immersed in their daily lives with the technological connection of videos, audios and images shared on instant messaging platforms such as WhatsApp group. Factors that indicated that instant messaging on mobile devices has enormous potential, but should never replace the physical means of communication.

A notable result through unstructured interviews was that students prefer the exchange of audiovisual resources through the WhatsApp group and not through the virtual classroom of the educational institution. In other aspects, they recommended generating explanatory videos of the laboratories and placing them on YouTube for easier and 24-hour consultation. As a common factor, it has been reached that electronic materials and short video contribute to achieve laboratory skills, as an essential element required for problem solving, creativity and teamwork (Del Savio et al., 2023).

In Mozambique, 38% of the students in the control group failed the laboratory section exam, while in the experimental group this decreased by 25%. Consequently, there was an improvement of 13% in the passing grades of the students. On the other hand, 47% of the control group from Cuba failed the exam, compared to 18% in the experimental group. In fact, students with passing grades increased by 29%. Finally, the students of the Catholic University Sedes Sapientiae, in the 2023-1 course 26% failed the exam, compared to the 2023-2 course, which decreased by 8%. Likewise, there was an improvement of 12% in the passing grades of the students. In general, the average laboratory grade of the control group was 11.10 while the experimental group had a grade of 12.48. Thus, it is shown that there is a slight improvement in students' academic performance as a result of the effectiveness of the audiovisual resources in the inverted classroom.

The best results of the grades in course 2023-2 of the students of the University of Ciego de Avila were observed. The possible cause is considered to be the result of the implementation of the massive informatization program of ICT since 2005. As a result, it generated skills in students in the search and analysis of audiovisual information and consequently obtained better grades in relation to the students of the other universities analyzed. In this regard, Karla et al. in a survey of 95 students at the University of Havana recorded that 85%, 81%, 78%, 75% and 71% use the Internet for school work, social networks, mail, study and surf the Internet, which enables the immediate assimilation of audiovisual content.

However, the statistical analysis in Table 3 of the normality tests indicates significant differences between the two groups. The correlation coefficient of Spearman's test in the three educational institutions reached very low values between course 2023-1 and course 2023-2. Therefore, it follows that there is a high appreciation by students of a significant methodological difference and its impact on academic performance as those exposed by Campira et al. (2021) and Mendonça et al. (2012).

During the research, it was detected some inconveniences of access to the internet and technology in Mozambique and Cuba, which influenced in some aspects the capacity of students to receive the authentic audiovisual media. In this same context, several researchers have shown that the scarce technological means and internet connections hinder the opportunities to expand audiovisual resources from the perspective of the flipped classroom (Campillo-Ferrer & Miralles-Martínez, 2021; Cartes-Barroso, 2022; Duan et al., 2021; Seibert et al., 2013).

An important finding was that the government's public policies encourage audiovisual education through programs on television channels such as Canal Multivisión. In this way, competencies, learning and interdisciplinary research are strengthened. All of which, generated more facility for the insertion of the experimental group with a visual, formative and motivational environment with a wide profile in the students. In this regard, De La Torre & Díaz-Luc (2023) demonstrated that television is a transcendent alternative to broaden the interest of academic courses.

5. Conclusions

The objective of this article was to establish how the use of audiovisual resources such as videos, images, texts, electronics and instant messaging in inverted classrooms applied to civil engineering laboratories improves student performance. For this purpose, the overall performance of students was evaluated by means of three factors such as: degree of student satisfaction, student performance during laboratory practice, and finally contrasting the method by means of audiovisual resources.

An improvement in satisfaction was demonstrated because more than 162 students, representing 70% of the experimental group, were satisfied, as was the case with academic performance. Although, in general, the improvements in grades were insignificant, only 11%. However, the number of students who failed in the laboratory decreased significantly by 21%. Therefore, it is concluded that the traditional laboratory has significant differences with respect to the laboratory through audiovisual resources.

Most of the students of the three academic institutions positively valued the laboratory practice of the inverted classroom with audiovisual resources in relation to the traditional laboratory. Consequently, there was a high degree of favorable acceptance of factor 1 in Q8 and Q9 as well as, factor 2 in Q7 aimed at contributions of study habits, recommendation of the laboratory with audiovisual media and validity of audiovisual resources for learning and improvement of academic performance. Among the platforms and materials shared to students mostly preferred instant messaging by WhatsApp and video as a didactic resource because it provided them with greater skill and confidence immediately with the observation of the laboratory procedure and analysis. Due to this process, students' doubts in the execution of the laboratory were decreased and in the exam they showed accurate results and ideas, as well as reflective conclusions and recommendations between theory and practice.

A significant finding of the research is the positive impact of the inverted classroom with audiovisual resources, which provides a comprehensive pedagogical tool to effectively address the problems presented by students in laboratories in different geopolitical environments. However, further studies are needed to understand the effect in interdisciplinary conditions encountered by the civil engineering student.

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