EdDevOps Teaching and Learning Method: Impacts on IS Students' Performance and Motivation

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Abstract. *This study presents EdDevOps, a teaching method developed through the didactic transposition of practices drawn from agile and DevOps approaches. EdDevOps was applied alongside a traditional teaching method in an undergraduate course, providing a comparative basis with the approach commonly used in higher education. Its contributions were assessed through student grades and motivation levels. Results show that students achieved higher scores with EdDevOps, particularly those with lower academic performance, and higher levels of motivation in general. This study contributes to research on didactic transposition and to the improvement of teaching practices in Information Systems.*

Resumo: *Esta pesquisa apresenta o método de ensino EdDevOps, desenvolvido nesta pesquisa por meio da transposição didática de práticas advindas dos métodos ágeis e de DevOps. EdDevOps foi aplicado em paralelo a um método tradicional de ensino em uma disciplina de graduação, de modo a oferecer uma base comparativa ao método de ensino que usualmente é utilizado no ensino superior. As contribuições de EdDevOps foram avaliadas por meio das notas e da motivação dos alunos. Os resultados indicam que, com EdDevOps, os alunos apresentaram notas mais altas, principalmente aqueles com menor desempenho acadêmico, além de maiores níveis de motivação em geral. Esta pesquisa contribui para estudos relativos à transposição didática, bem como para o aprimoramento das práticas de ensino em Sistemas de Informação.*

1. Introduction

Information Systems (IS) undergraduate programs encounter three main challenges in ensuring student success, directly impacting traditional teaching and learning methods in IS education. First, traditional teaching methods often struggle to engage students, who tend to prefer more interactive and applied learning experiences (O'Connor, 2022). Second, as IS practices rapidly evolve, academic curricula frequently lag behind industry needs, creating a gap between education and professional requirements (Fernandes *et al.*, 2020). Finally, while DevOps practices are widely recognized in the industry (Hobeck *et al.*, 2021), they remain an emerging topic in IS higher education (ACM & AIS, 2021).

Innovating teaching methods is an aspect that is mostly under the responsibility of professors (Chevallard & Bosch, 2020). In our previous study (Grotta & Prado, 2022),

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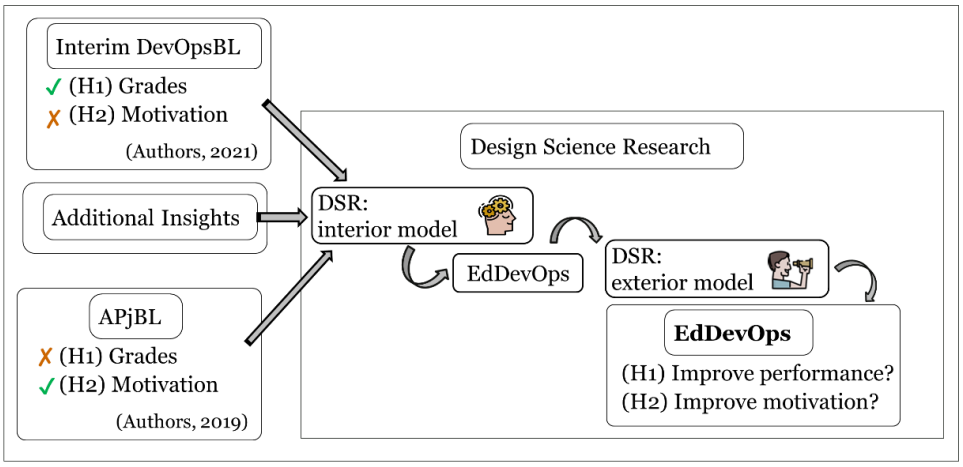
we introduced the concept of DevOps-Based Learning (DevOpsBL) to describe the didactic transposition of DevOps practices into IS education learning environments. Additionally, our prior research identified two key indicators of learning effectiveness in DevOpsBL: students' academic performance and motivation (Grotta & Prado, 2021, 2022). Grounded in this foundation, this study presents an instance of a DevOpsBL teaching method called EdDevOps, derived from the combination of "Education" and "DevOps." EdDevOps was designed using the interior model of Design Science Research (DSR). Its validation was conducted through the DSR exterior model as part of its application in a higher education course on IS Project Management.

Therefore, this research presents EdDevOps and investigates its impact by analyzing two student indicators: academic performance, determined by final grades, and motivation, measured through a motivational survey adapted from Boruchovitch (2008) and Grotta & Prado (2019). The main objective of this research is to examine the impact of the EdDevOps method on student performance and motivation in IS higher education courses. It aims to answer the following research question: How does the EdDevOps method impact students' academic performance and motivation in an IS undergraduate program?

2. Methods

This is an exploratory and applied study (Creswell & Creswell, 2021), focusing on the contribution of EdDevOps to students' grades and motivation within IS higher education. The research reference model was developed based on the DSR exterior and interior models for IS (Baskerville *et al.*, 2018; Venable *et al.*, 2017). The interior model was utilized to develop the EdDevOps teaching and learning method, incorporating lessons learned from i) an Agile Project-Based Learning (APjBL) teaching method (Grotta & Prado, 2019); ii) an interim DevOpsBL teaching method (Grotta & Prado, 2021); and iii) insights from field research during 2021 and 2022 (Grotta & Prado, 2023). This period spanned the pre-pandemic, pandemic and post-pandemic phases of COVID-19. To validate EdDevOps, the DSR exterior model was utilized as illustrated in Figure 1.



Legend: **H1:** the teaching method improves students' grade?
H2: the teaching method improves students' motion?
✗ **:** Not confirmed
✓ **:** Confirmed

Figure 1. Research Reference Model

Pure experimental procedures are rarely feasible in education due to constraints such as the randomization of curricular components, students, and/or instructors (Shadish *et al.*, 2002). Therefore, we utilized an educational quasi-experiment to validate EdDevOps under both students' grades and motivation aspects, based on two hypotheses (H1 and H2), relating the teaching methods to students' grades and motivation as follows:

> **(H1):** EdDevOps improves students' grades compared to the lecture-based teaching method. Academic grades are widely used as indicators of student achievement (Brookhart *et al.*, 2016). Therefore, this hypothesis investigates the impact of EdDevOps on students' grades.
>
> **(H2):** EdDevOps improves students' motivation compared to the lecture-based teaching method. Motivation is recognized as a core competence for academic and professional success, and it is a central focus in higher education (Boruchovitch, 2008). Thus, this hypothesis examines the impact of EdDevOps to students' motivation.

Therefore, as detailed in Table 1, the research variables were derived from hypotheses H1 and H2. The study employs a mixed-methods analysis (Creswell & Creswell, 2021) with an emphasis on the quantitative data: student grades (ratio) and motivation scores (ordinal). As a rationale for the mixed-methods approach, these two variables were quantified from sources such as student evaluation records and the motivation survey.

Table 1. Research Variables

Variable	Type	Interval	Details
Teaching methods	Nominal	Lecture or EdDevOps	Based on the pedagogical procedures detailed in the next subsection.
Course content	Nominal	Conceptual	As described in the Theoretical Bases section (Anderson *et al.*, 2001).
Students' Outcomes			
• Grades	Ratio	5 ~ 10	Students' approval range, based on students' evaluations results
• Motivation	Ordinal	1 ~ 5 (Likert scale)	Students' motivation to learn: adapted from Boruchovitch (2008) and Grotta & Prado (2019) as follows.

Finally, the use of generative AI was strictly limited to the purpose of proofreading and refining the manuscript's language. It was not used for generating text or analyzing data. All statistical analyses were performed using electronic spreadsheets and the JASP statistical software.

2.1 Data Collection Instruments

On the final day of the course, students' grades were published and collected from student records. To avoid bias or grade-related expectations, students who felt comfortable participated in a survey only after the grades were disclosed. The adapted survey was previously validated in Brazilian Portuguese to minimize potential misinterpretation bias. It used a Likert scale: (1) Strongly disagree; (2) Disagree; (3) Neutral; (4) Agree; (5) Strongly agree, to assess both intrinsic and extrinsic motivation. The survey also

facilitated a side-by-side comparison between lecture-based and EdDevOps methods. Additional data, including age and self-perceived motivation, were collected to provide further participant characterization.

2.2 Research Context

The study was conducted at a leading higher education institution in Latin America, which has multiple campuses across São Paulo state, Brazil. The selected campus, located in a major metropolitan area, offers undergraduate and graduate programs and is recognized for its adoption of active learning methodologies. Among its programs, the Management & Information Systems (MIS) degree was chosen for this research. This eight-semester course, with annual admissions, focuses on computing technology and prepares students to develop information systems for public and private organizations, aligning with the research objectives.

The MIS curriculum begins with foundational courses in early semesters, followed by computing-focused subjects and complementary disciplines such as administration and entrepreneurship. The IS Project Management course, offered in the sixth semester, covers project management principles, lifecycle methodologies, and related practices, with an emphasis on waterfall, agile, and software engineering management methods. The research was conducted during the second semester of 2022. Initially, 51 students enrolled in the study, though four later withdrew or deferred the course, leaving a final sample of 47 students. When the course finished, 39 students participated in a detailed survey. The survey indicated that 69.2% of students considered themselves motivated, while 20.5% disagreed, and 10.3% remained neutral. Additionally, 84.6% identified themselves as IS professionals, and 97.4% intended to pursue a career in the field.

2.3 Research General Limitations

This research has four main limitations. First, this research is valid only within the studied context; therefore, the results cannot be generalized to other settings (Creswell & Creswell, 2021). The second limitation concerns the instruments used to measure changes in human behavior, which were restricted to the following dimensions: intrinsic and extrinsic motivation (Boruchovitch, 2008). This research was submitted to and approved by the University's Research Ethics Committee under protocol number [suppressed]. Third, generative artificial intelligence was utilized to complement human revision, focused on grammar and spelling review to enhance clarity and correctness. No content generation, data analysis, or conceptual development was performed by AI. Finally, this research is part of broader research.

2.4 Research Teaching Protocol

Two teaching methods were implemented concurrently in the IS Project Management course: a lecture-based approach and the EdDevOps method. The course began with a joint inaugural session, where both instructors introduced themselves, outlined the course objectives, explained the teaching strategies and evaluation criteria, and established fixed student teams for use across both methods. The lecture-based approach, led by one instructor, relied on traditional expository teaching over 18 class sessions, covering key topics such as project scope, scheduling, costs, quality, and resource management. The sessions included discussions and individual written assessments. The EdDevOps

method, administered by the other instructor, was organized into two four-day sprints, integrating agile and DevOps principles through practical activities. These included defining agile project scopes, developing user stories, and managing iterative deliverables. Group assessments were conducted at both the middle-term and the final-term (end of the course) evaluations.

2.5 EdDevOps

EdDevOps is an innovative teaching method for higher education courses in IS, integrating agile and DevOps practices, as illustrated in Figure 2. The method consists of eight stages — four dedicated to development (steps 1–4) and four to operations (steps 5–8). This framework simulates real-world scenarios, enabling instructors and students to synergy both Dev and Ops practices within the teaching environment.

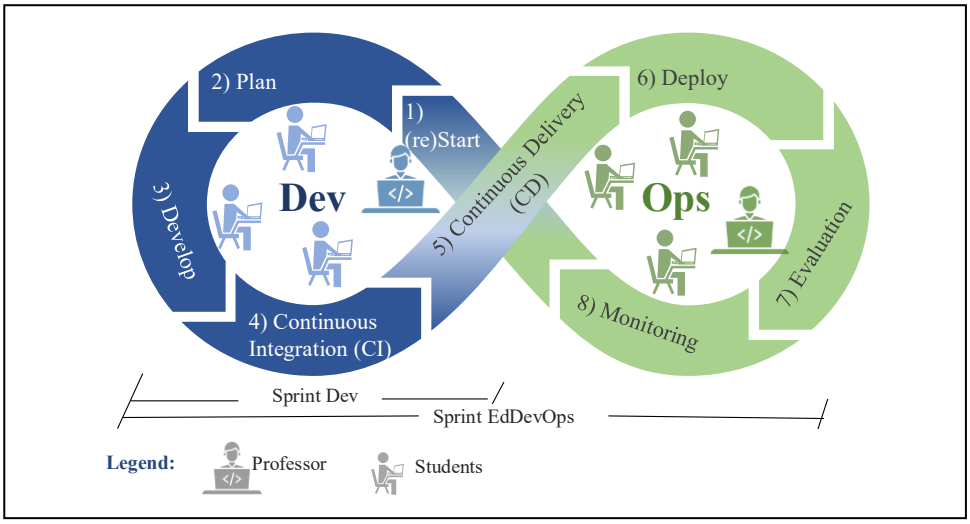


Figure 2. EdDevOps Graphical Representation

EdDevOps is organized in two sequential phases: course planning and course "in-class" practices, or simply practices, as shown in Figure 3.

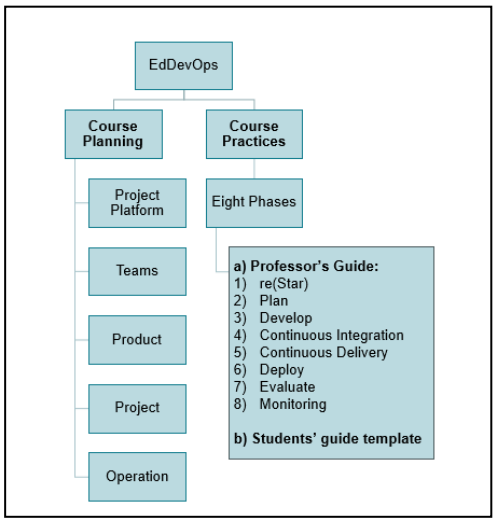


Figure 3. EdDevOps Plan, Practices and Template

As a brief explanation of Figure 3, the course planning, the professor designs the structure by defining the project platform, team formation, and the scope of both product and project operations. This initial phase establishes the expectations regarding roles, responsibilities, and workflows, while aligning with academic objectives and IS practices. During class, the professor introduces the method in eight stages. The first four address development (project (re)initialization, planning, development, and continuous integration). The following four focus on operations (continuous delivery, deployment, evaluation, and monitoring). Concurrently, students use a dedicated template to organize project details, track progress, and document key elements.

2.5.1 EdDevOps Course Planning

In the planning phase, the professor undertakes a systematic preparation process prior to the implementation of EdDevOps. This phase is organized around five key elements: selecting the project platform, defining team formation, and planning the product, project, and operations. This preparatory work is critical for aligning project activities with academic objectives and IS practices, ensuring that the educational experience mirrors the practical challenges and methodologies observed in current industry settings.

Moreover, the planning stage provides detailed orientations and strategic suggestions for the subsequent application of EdDevOps. The professor's design includes extensive pre-course activities, such as the formulation of a structured planning model to guide the development of the project and product. Recommendations drawn from literature and empirical studies reinforce the emphasis on early team formation and a contextualized product definition, thereby reducing cognitive load and promoting efficiency once the course is underway.

2.5.2 EdDevOps Course Practices

During class, EdDevOps is implemented through a series of eight distinct stages that collectively form a single sprint cycle. The method is initiated under the professor's guidance, who progressively familiarizes students with each stage, facilitating the transition from theoretical knowledge to practical application.

The sprint division into two clearly defined segments – development and operations – ensure that students experience the entire project lifecycle while engaging with both the creation and maintenance aspects of an IS project. The initial stages focus on project (re)initialization, planning, development, and continuous integration. They are designed to establish the technical foundations of the project, rapidly setting the context and scope for product and project development. The subsequent stages focus on operational activities: continuous delivery, deployment, evaluation, and monitoring. Therefore, the professor guides students through operational challenges, such as package delivering and system deployment, if possible, by using simulated real word environments.

An important characteristic of these in-class practices is the balance between teacher-led and student-led activities. While the professor maintains a supervisory role during critical stages, particularly during the initial project definition and later evaluation, the other processes are delegated to students with supervision. This structure fosters autonomy and situational learning, enabling students to make real-time decisions regarding task distribution, role assignment, and the integration of feedback. The

approach also emphasizes iterative learning, as students are encouraged to reflect on outcomes from previous sprints and adjust their strategies accordingly.

2.5.3 EdDevOps Template

A dedicated spreadsheet template supports the EdDevOps process by serving as a dynamic tool for recording and tracking project details. Initially completed by the professor to set the foundational parameters for the project, the template is subsequently updated by students throughout the course. It provides a structured format for documenting progress, organizing tasks, and ensuring that all critical elements, from team formation up to task allocation. All this information is recorded and enhanced during the course, supporting both planning accuracy and ongoing project management activities.

3. Results and Discussions

The course initially enrolled 51 students; however, four either withdrew or received course exemptions, making them ineligible for further participation. Consequently, their corresponding IDs (2, 8, 18, 20) were excluded from the dataset, leaving 47 students, as shown in Table 2. By the end of the study, 39 students had completed the survey, while others had missing values in the dataset. Across all measured metrics, students performed better under the EdDevOps method than under the lecture-based teaching method. Performance was higher in 91% of cases, intrinsic motivation in 79%, extrinsic motivation in 74%, and overall motivation in 90%, demonstrating the impact of EdDevOps on the same students exposed to both methods.

Table 2. Students' Grades and Attendance

Student	Performance			(a) Intrinsic Motivation			(b) Extrinsic Motivation			Motivation((a+b)/2)		
ID	L	E	Lead	L	E	Lead	L	E	Lead	L	E	Lead
1	4.5	10	E	3.36	3.36	=	2.92	2.92	=	3.14	3.14	=
3	6.7	9.3	E									
4	5.8	9.3	E	3.00	3.36	E	2.42	2.83	E	2.71	3.10	E
5	7.9	9.7	E	3.21	3.21	=	2.92	2.92	=	3.07	3.07	=
6	8.5	10	E	4.21	4.64	E	3.75	3.83	E	3.98	4.24	E
7	3.6	10	E	2.93	3.43	E	2.67	3.25	E	2.8	3.34	E
9	6.5	10	E	3.36	4.29	E	3.17	4.08	E	3.26	4.18	E
10	7.1	10	E	3.43	3.64	E	3.08	3.17	E	3.26	3.4	E
11	8.7	10	E	3.36	3.57	E	3.17	3.17	=	3.26	3.37	E
12	8.2	10	E	2.79	4.43	E	2.67	3.33	E	2.73	3.88	E
13	4.1	10	E									
14	5.9	8.8	E	3.00	3.29	E	3.08	3.25	E	3.04	3.27	E
15	5.2	9.7	E									
16	5.0	10	E	4.64	5.00	E	4.00	4.08	E	4.32	4.54	E
17	2.5	9	E									
19	7.9	10	E	2.71	2.57	L	2.75	2.92	E	2.73	2.74	E
21	5.7	8.8	E	1.79	3.29	E	2.42	3.17	E	2.1	3.23	E
22	7.4	10	E	4.07	4.14	E	3.58	3.75	E	3.83	3.95	E
23	7.3	9.3	E	3.57	3.71	E	3.25	3.67	E	3.41	3.69	E
24	6.0	9.3	E	2.43	2.71	E	2.92	2.92	=	2.67	2.82	E
25	6.6	9.3	E									
26	4.1	8.8	E	4.29	4.29	=	2.92	3.00	E	3.6	3.64	E
27	5.5	7.6	E	2.07	2.07	=	2.08	2.17	E	2.08	2.12	E
28	6.7	8.8	E	2.86	3.57	E	2.50	3.17	E	2.68	3.37	E
29	7.8	9.2	E									
30	9.8	9.5	L	2.07	2.14	E	2.42	2.5	E	2.24	2.32	E
31	6.7	9.7	E	2.57	3.29	E	2.5	2.92	E	2.54	3.10	E
32	4.9	9.3	E	3.29	4.79	E	3.00	3.67	E	3.14	4.23	E
33	4.0	10	E	3.5	2.36	L	2.83	2.42	L	3.17	2.39	L
34	6.5	10	E	4.00	3.86	L	2.75	2.75	=	3.38	3.30	L
35	4.2	10	E									
36	4.9	10	E	3.43	3.64	E	3.08	3.00	L	3.26	3.32	E

Student	Performance			(a) Intrinsic Motivation			(b) Extrinsic Motivation			Motivation((a+b)/2)		
ID	L	E	Lead	L	E	Lead	L	E	Lead	L	E	Lead
37	10	9.5	L	2.71	3.36	E	3.17	3.00	L	2.94	3.18	E
38	7.2	8.8	E	3.00	3.14	E	3.00	3.25	E	3.00	3.20	E
39	8.3	9.7	E	4.14	4.86	E	3.08	3.75	E	3.61	4.30	E
40	4.3	9.7	E									
41	10	10	=	2.07	3.79	E	2.83	3.50	E	2.45	3.64	E
42	9.0	9.7	E	4.00	4.5	E	3.42	3.50	E	3.71	4.00	E
43	6.6	8.8	E	4.57	4.64	E	2.75	3.25	E	3.66	3.95	E
44	9.2	9.7	E	3.64	3.93	E	2.83	3.25	E	3.24	3.59	E
45	8.7	8.7	=	3.93	4.14	E	3.75	3.75	=	3.84	3.95	E
46	8.7	9.3	E	3.79	4.07	E	3.25	3.42	E	3.52	3.74	E
47	5.5	8.8	E	3.57	3.57	=	3.5	3.58	E	3.54	3.58	E
48	7.9	10	E	4.21	4.29	E	3.75	4.00	E	3.98	4.14	E
49	7.4	9.8	E	3.43	3.64	E	3.00	3.33	E	3.21	3.49	E
50	8.2	10	E	3.79	3.93	E	3.5	3.50	=	3.64	3.71	E
51	3.3	9.5	E	2.50	4	E	1.75	3.58	E	2.13	3.79	E
Mean	6.6	9.5		3.32	3.71		2.99	3.27		3.15	3.49	
Median	6.7	9.7		3.36	3.64		3.00	3.25		3.21	3.49	
E > L		43	91%		31	79%		29	74%		35	90%
E = L		2	4%		5	13%		7	18%		2	5%
E < L		2	4%		3	8%		3	8%		2	5%

Legend: **L** = Lecture-based teaching **E** = EdDevOps **SE** = Standard Deviation

3.1 Analysis

The analysis and discussion of results are presented based on the research hypotheses (H1 and H2). To verify these hypotheses, the data were subjected to the Shapiro-Wilk normality test (Hollander, Wolfe & Chicken, 2013) to determine the appropriate statistical method for each case. The Shapiro-Wilk test indicated that the data used in the analysis of Hypothesis H1 follows a normal distribution, whereas the data for Hypothesis H2 exhibit deviations from normality.

As shown in Table 3 Hypothesis H1 was tested using Student's t-test (Anunciação, 2021), while Hypothesis H2 was tested using the Wilcoxon test (Hollander, Wolfe & Chicken, 2013). The results of the hypothesis verification are presented in Table 3. The analyses were conducted at a 5% significance level. All hypotheses were tested to confirm whether the values associated with the EdDevOps method were higher than those associated with the lecture-based method.

Table 3. Hypothesis Verification

Hypothesis	Normality Check		Statistic Test				
	S	p(s)	Type	value	p	Influence	confirmed?
H1 (grades)	0.959	0.094	Student' t-test	t = 10.447	< .001	Cohen's d = 1.524 (strong)	yes
H2 (motivation)	0.867	< .001	Wilcoxon	W = 664.0	< .001	RBC = 0.889 (strong)	yes
└ intrinsic	0.866	< .001	Wilcoxon	W = 552.0	< .001	RBC = 0.855 (strong)	yes
└ extrinsic	0.854	< .001	Wilcoxon	W = 493.5	< .001	RBC = 0.869 (strong)	yes

Legend: S = Shapiro-wilk; **p(s)** = statistically significant values (<0.005) indicate deviation from normality;
RBC = Rank-Biserial Correlation

Hypothesis H1 was confirmed: this result suggests potential benefits in using EdDevOps to enhance student performance. The EdDevOps method improved student performance in most cases, particularly among students with lower academic performance in the lecture-based teaching method. This finding supports the argument made by Biggs and Tang (2011) that, in higher education, students with lower academic performance often face greater difficulties compared to higher-performing students, which is reflected in differences in grades.

Hypothesis H2 was confirmed: this result suggests that the EdDevOps method positively influenced both intrinsic and extrinsic dimensions of motivation and showed a strong correlation with the results. These findings align with the literature (Grotta & Prado, 2022), which consistently highlights motivation improvement as one of the most frequent benefits associated with DevOps. Thus, within the studied context, it is reasonable to infer that EdDevOps contributes to more engaging and motivating lessons.

3.2 Discussions

Hypothesis H1 was confirmed, indicating potential benefits of the EdDevOps teaching method in improving student performance. Figure 2 supports this discussion by presenting student grades ordered in ascending order based on the lecture-based method. The results show that EdDevOps improved student performance in most cases, particularly among those with lower academic performance in the lecture-based method. This finding aligns with (Biggs & Tang, 2011) who state that, in higher education, lower-performing students tend to face greater difficulties compared to their higher-performing peers, which is reflected in grade differences.

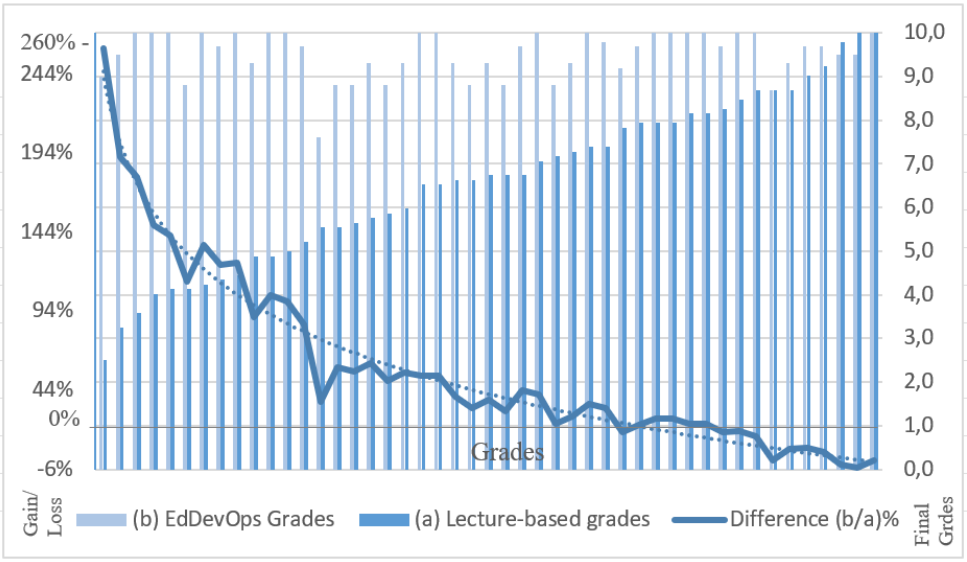


Figure 3. Graphical Representation of the Grades

Biggs and Tang (2011) also argue that more participatory and active teaching methods are generally more engaging for students than lecture-based approaches. Therefore, regarding Hypothesis H2, it is reasonable to infer that EdDevOps contributes to more engaging classes. Additionally, EdDevOps outperformed our previous research (Grotta & Prado, 2021) in both grades and motivation, as it demonstrated the ability to improve these indicators in conceptual courses. This research contributes to the literature in three key areas: (1) enhancing learning methods, particularly those aligned with student-centered approaches (SCA), as advocated by (Børte *et al.*, 2023); (2) advancing the didactic transposition of Information Systems (IS) practices into higher education in a structured and beneficial manner (Fernandes *et al.*, 2020); and (3) Enhancing student motivation to fosters a more motivated attitude toward academic and professional challenges (Nwokeji *et al.*, 2019).

4. Conclusion Remarks

The main objective of this research was to examine the impact of the EdDevOps method on student performance and motivation in IS higher education courses. This analysis was guided by two research hypotheses comparing performance and motivation outcomes of students exposed to both the lecture-based method and the EdDevOps method. Student outcomes served as the basis for evaluating the method's effectiveness. This objective was achieved through a quantitative research approach applied to IS education, following the DSR interior and exterior models.

In the context of this research, results indicate that EdDevOps led to better outcomes than the lecture-based method. These findings suggest that EdDevOps provides a structured yet hands-on learning experience for IS students in theoretical, classroom-based courses. Moreover, its implementation alongside the lecture-based method demonstrates that both approaches can coexist and complement each other, offering a teaching experience that balances theoretical and practical aspects. The rapid evolution of IS technologies presents ongoing challenges for students, particularly when learning is limited to passive knowledge transfer methods. As technological advancements accelerate and new IS practices emerge, adapting teaching methods becomes increasingly important. In this context, EdDevOps offers an alternative that fosters student development and broadens their professional prospects. This study applied EdDevOps to a theoretical course taught in a classroom setting rather than in labs. Future work will extend its application to other IS courses to further refine and enhance the method. The next step involves exploring the use of artificial intelligence in IS courses taught using EdDevOps.

Future research may adapt or replicate this research in other contexts, such as different IS courses and other educational levels, such as vocational high schools. Further inquiry could also incorporate qualitative methods to provide a richer understanding of pedagogical impacts and implementation challenges from different perspectives. Additional paths for investigation include the development of training models for EdDevOps educators, as well as the creation of supplemental resources, such as application guides and training frameworks. Finally, we encourage exploring the didactic transposition of other relevant industry practices beyond DevOps, helping to continuously align academic programs with professional demands.

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