A Long-Term Study of the Pandemic Impact on Education: A Software Engineering Case

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Introduction

Context

- COVID-19 **affected 87% of the world's student** population (1.5 billion students in 195 countries).
- **Shift to remote learning** using platforms, applications, and digital resources.

Introduction

Previous Studies

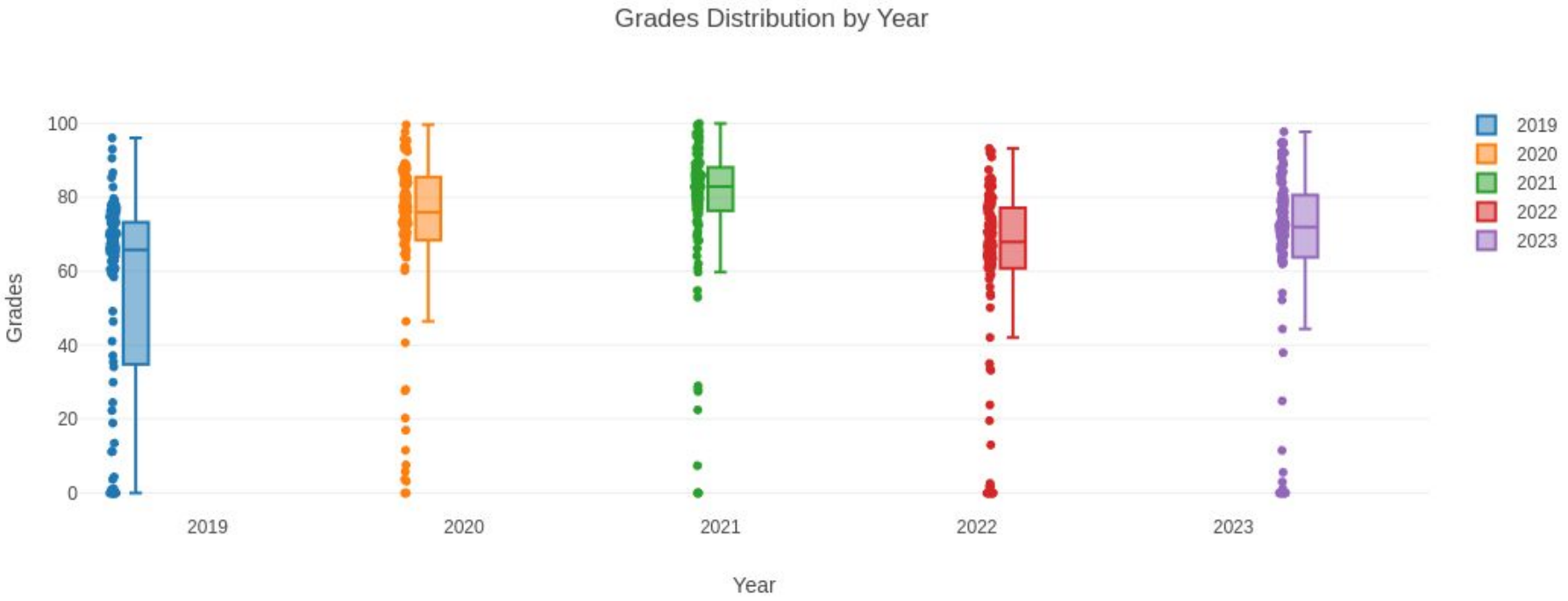
- Explored remote learning effects on performance and engagement in fields like Computer Science and Software Engineering.
  - De Deus et al. (2020): Emergency Remote Education in Brazil.
  - Barr et al. (2020): Rapid online learning shift in Software Engineering programs.

Introduction

Research Gap

- No quantitative studies on the long-term impact of the pandemic on student performance.
  - Our Contribution
    - Empirical study analyzing grades (2019-2023) for a Software Engineering course.
    - Focused on in-person learning; excluded 2020-2021 (remote learning years).

Introduction



The Software Engineering Course

- Duration: 60-hour semester course.
  - Target Audience: Computer Science and Information Systems.
  - Objective: Equip students with essential concepts and techniques for developing complex software systems.

The Software Engineering Course

- Course Content
  - Software development processes, agile methods, requirements analysis, design, architecture, implementation, testing, and quality.
  - Weekly topics paired with contextualized problems.
  - Assessment: Exam questions throughout the semester.

General Scope

Pandemic influences in Student Perform

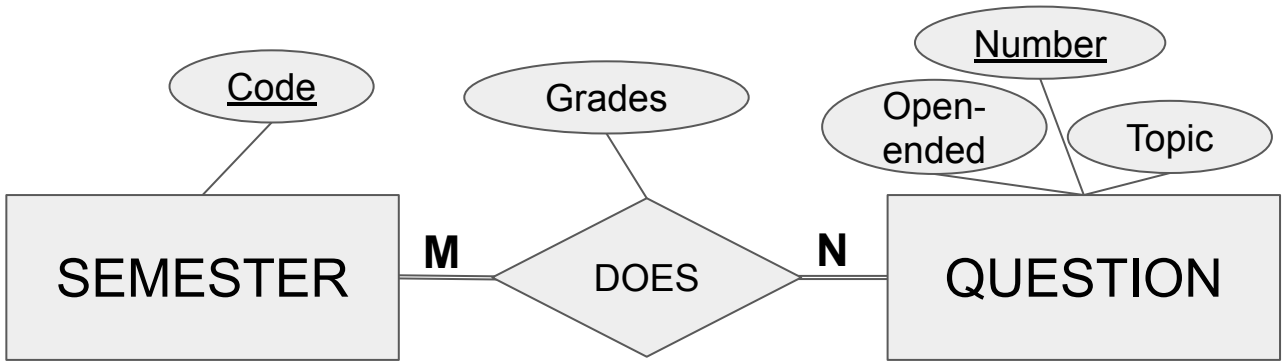
- **RQ1:** What was the impact of the COVID-19 pandemic on student performance?
- **RQ2:** How long the impact of the COVID-19 pandemic on student performance last?

Specific Scope

Pandemic influences in Student Perform

- **RQ3:** How did the COVID-19 pandemic impact the academic performance of **gender** students in the course?
- **RQ4:** How did the COVID-19 pandemic affect student performance in **open-ended and closed-ended** questions?
- **RQ5:** What was the impact of the COVID-19 pandemic on student performance related to **specific class topics** during the course?
- **RQ6:** How did the strength of the relationship between **student engagement frequency** and **academic performance** change before and after the pandemic?

General Concept Database Model



Question 11

- For the following practices, identify the agile method with the best fit. Use the following legend: (X) for Extreme Programming, (S) for Scrum or (B) for Both (3 pts)
    - [ ] Test-driven development
    - [ ] Refactoring
    - [ ] Pair programming
    - [ ] Customer involvement
    - [ ] Collective code ownership
    - [ ] Daily 15-minute meetings
    - [ ] Sustainable pace without overtime
    - [ ] Short interactions and frequent deliveries
    - [ ] 8-hour sprint planning meeting
- The resolutions of the questions are based on the materials provided by the course instructor. If necessary, the students can confer the answer and ask for a review.

Question 11 and Semester 2019-2

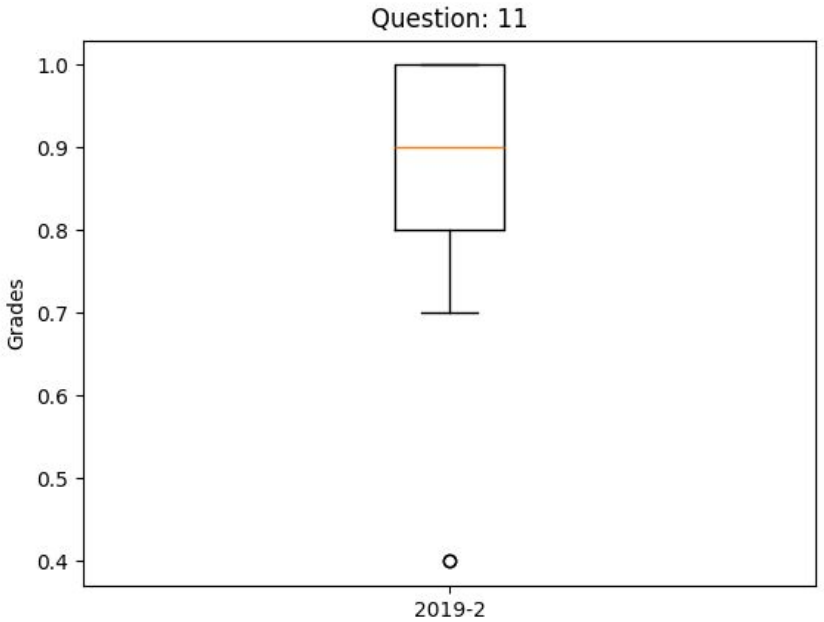
{ Tuple: {

Question = 11,

Semester = '2019-2',

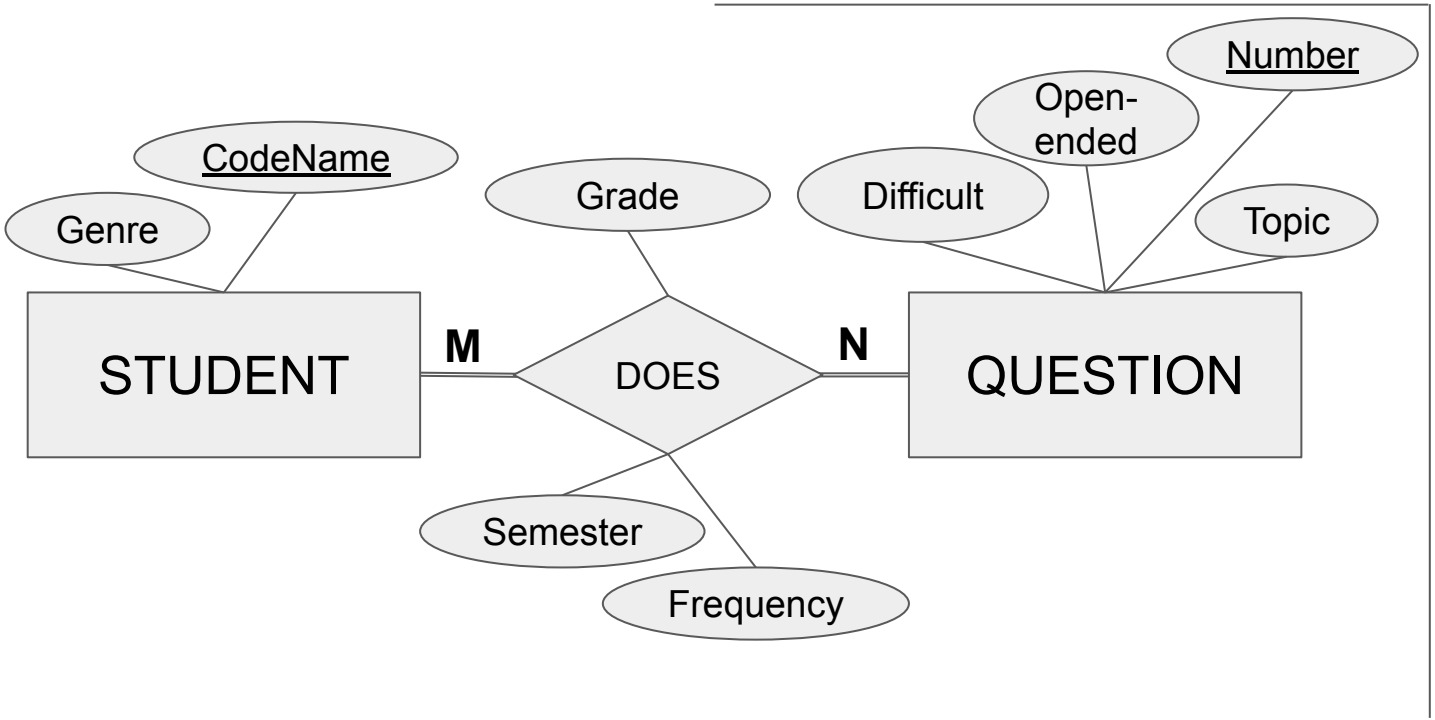
grades = [1.0, 1.0, 1.0, 0.8, 1.0, 0.8, 0.8, 1.0, 0.8, 0.9, 0.9, 0.7, 0.9, 1.0, 0.9, 1.0, 0.8, 0.8, 0.9, 0.7, 0.4, 0.8, 0.8, 0.7, 0.9, 1.0, 1.0, 1.0, 0.7, 0.8, 0.8, 0.9, 0.4, 1.0, 0.9, 0.8]}

}



Boxplot result of 36 student in second semester of 2019

Concept Database Model



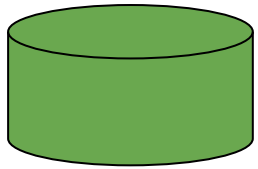
Implementation Database Model

Relation:

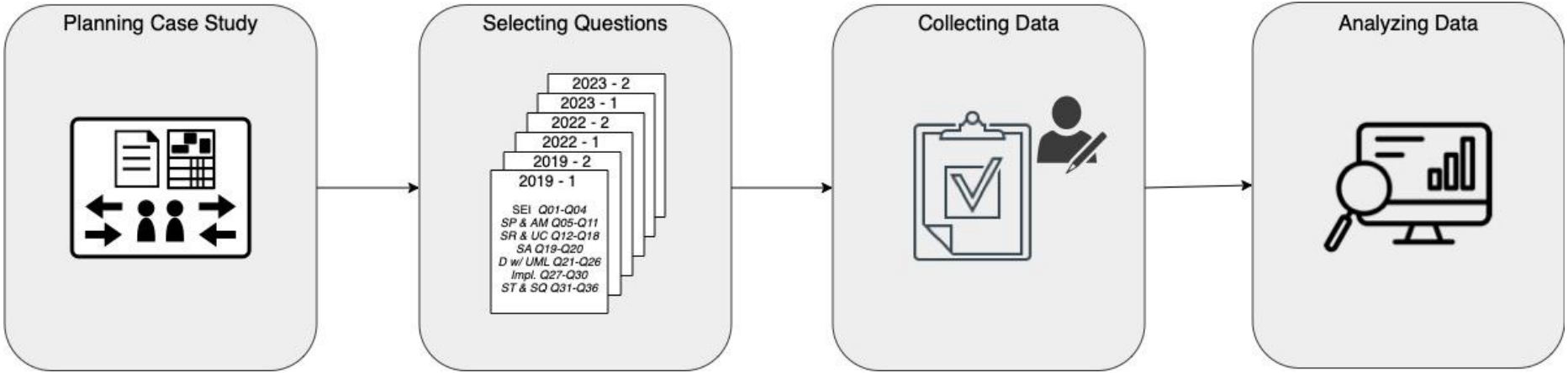
- Student
  - 288
- Question
  - 36
- Does
  - 4842 Total
  - 3102 Valid

code_name	gender	semester	frequency	number	topic	grade
student123	Female	2022-2	0.17	14	Software Requirements and Use Cases	
student049	Male	2019-2	0.63	30	Implementation	0.6
student248	Male	2023-1	0.7	34	Software Testing and Software Quality	1
student181	Male	2022-2	0.6	22	Design with UML	0.7
student029	Male	2019-1	0.47	9	Software Procesess and Agile Methods	1
student086	Male	2019-2	0.97	6	Software Procesess and Agile Methods	0.83
student234	Male	2023-1	0.9	25	Design with UML	0
student244	Male	2022-2	0.83	26	Design with UML	0.17
student162	Male	2022-1	0.37	10	Software Procesess and Agile Methods	

Semesters: 2019-1, 2019-2, 2022-1, 2022-2, 2023-1, 2023-2



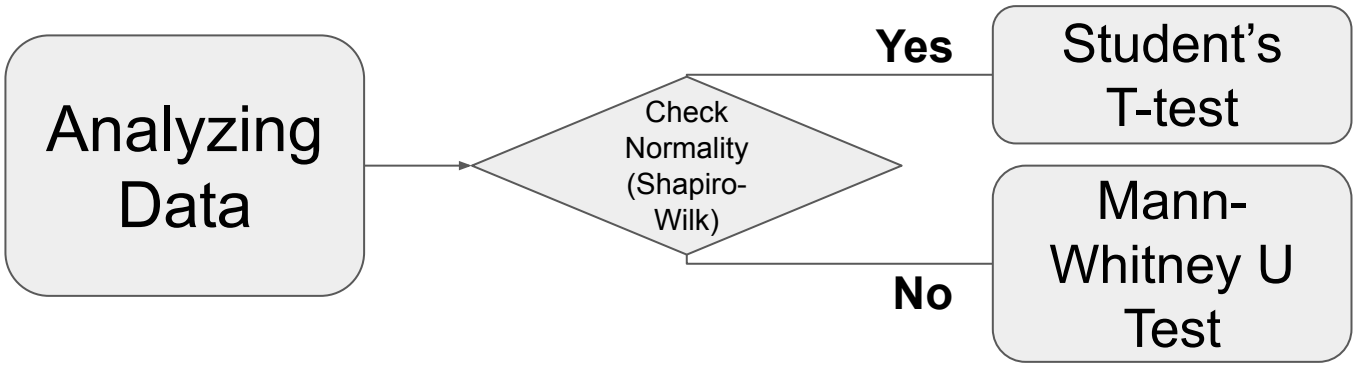
Study Settings



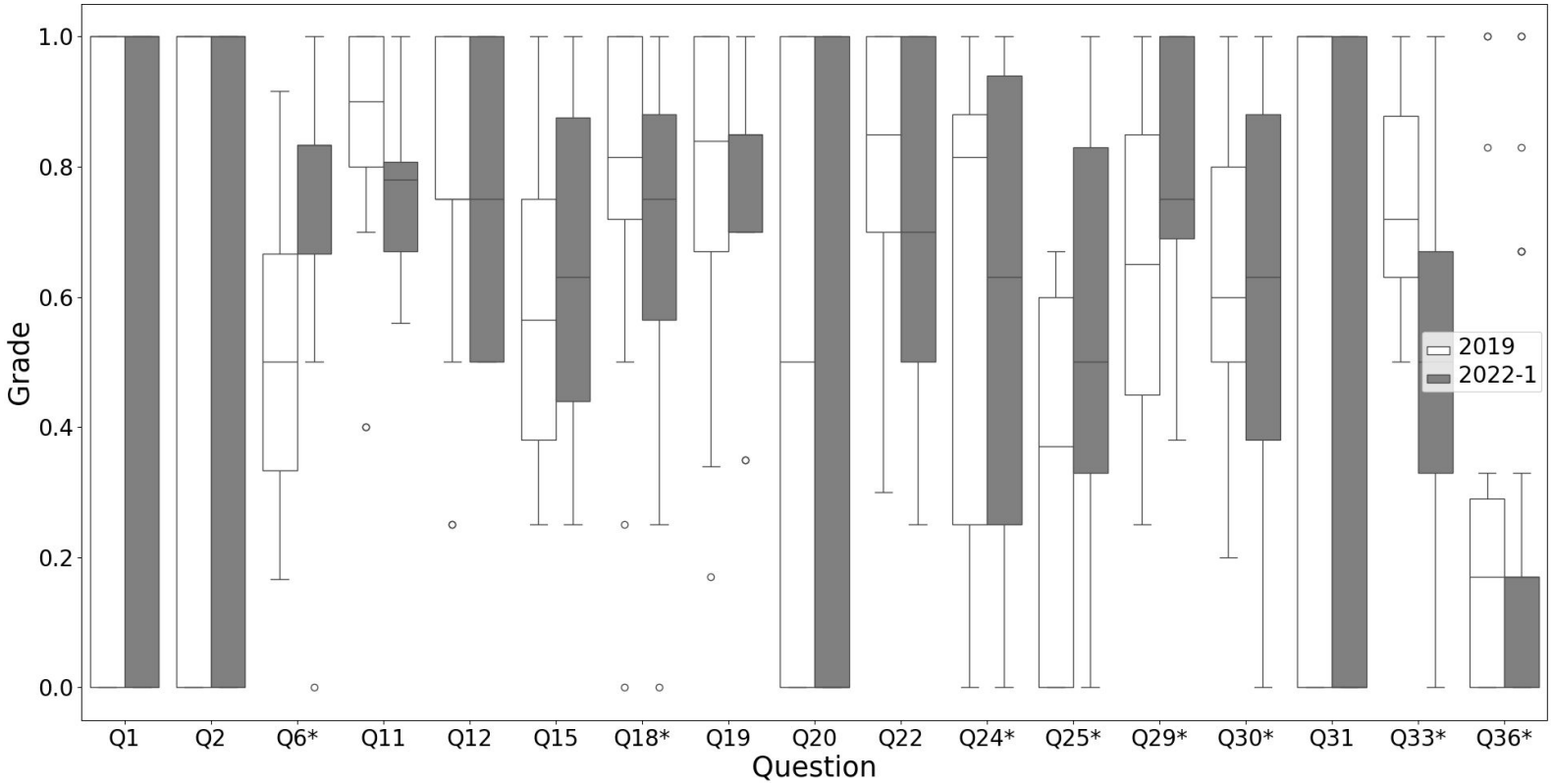
Study Settings

Hypotheses To RQs:

- Null Hypothesis (H_0): No significant difference in performance.
- Alternative Hypothesis (H_1): Significant difference in performance.



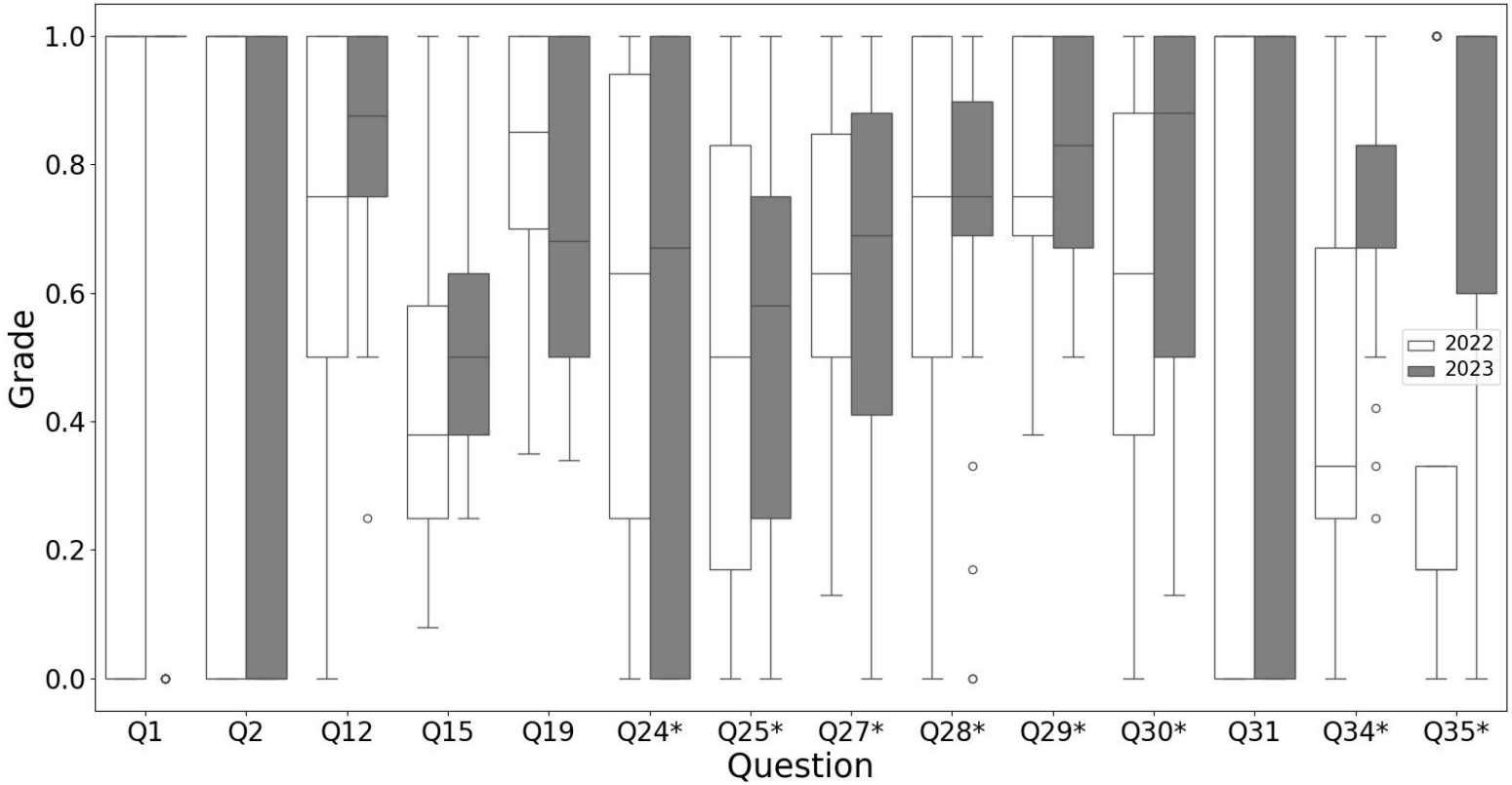
Results


1.0
0.8
0.6
0.4
0.2
0.0
Grade
Q1
Q2
Q6*
Q11
Q12
Q15
Q18*
Q19
Q20
Q22
Q24*
Q25*
Q29*
Q30*
Q31
Q33*
Q36*
Question
2019
2022-1

Results

1. **Normality Test:**
    - **Shapiro Test:**
        - W = 0.874, ρ < .001.
        - Data is not normally distributed.
2. **Statistical Test Applied:**
    - **Mann-Whitney U Test (Non-Parametric):**
        - U = 378020, ρ = 0.007.
3. **Findings:**
    - Significant difference observed:
        - Performance in 2019 ≠ Performance in 2022-1.

Results

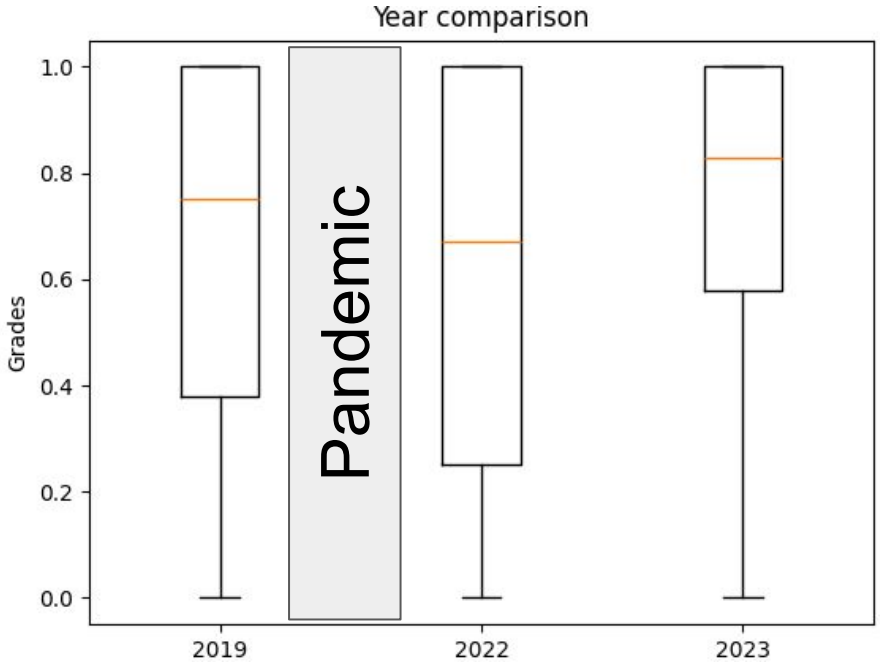

1.0
0.8
0.6
0.4
0.2
0.0
Grade
2022
2023
Q1
Q2
Q12
Q15
Q19
Q24*
Q25*
Q27*
Q28*
Q29*
Q30*
Q31
Q34*
Q35*
Question

Results

1. **Normality Test:**
   - **Shapiro Test:**
     - $W = 0.875$, $\rho < 0.001$.
     - Data is not normally distributed.
2. **Statistical Test Applied:**
   - **Mann-Whitney U Test (Non-Parametric):**
     - $U = 666506$, $\rho < 0.001$.
3. **Findings:**
   - Significant difference in student performance between 2022 and 2023 ($\mu 2022 \neq \mu 2023$).

Result

- Does the pandemic influence in student perform?



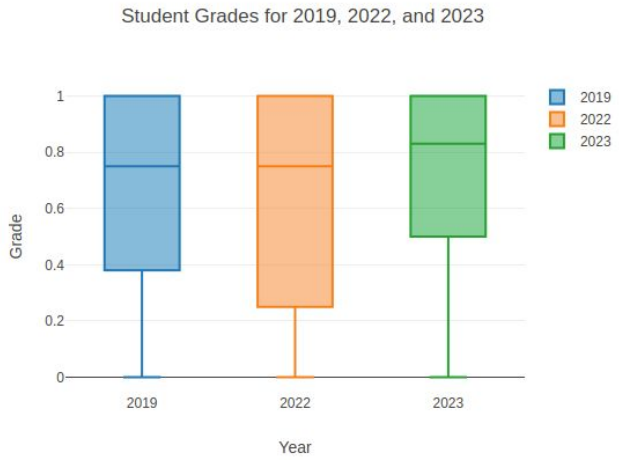
RQ1 **Summary:** The findings indicate that the COVID-19 pandemic may have had a negative impact on the performance of students across semester.

RQ2 **Summary:** Our findings reveal a significant improvement in student performance from the first year to the second year following the pandemic. Therefore, we argue that the pandemic impact on the student performance does not last long.

Specific Results In Progress

Specific Analysis Filter

Gender: All | Topic: All | Frequency: 0 1 | Question Type: All | Export to CSV



Year Stats

Year	Mean	Std Dev	Shapiro (W)	Shapiro (P-Value)	Normal?
2019	0.66	0.36	0.2621	0.01	No
2022	0.61	0.37	0.1895	0.01	No
2023	0.69	0.35	0.2845	0.01	No

Test Results

Year Pair	Test	P-Value	Significant
2019 vs 2022	Mann-Whitney U	0.00000	Yes
2019 vs 2023	Mann-Whitney U	0.00000	Yes
2022 vs 2023	Mann-Whitney U	0.00000	Yes

Specific Results In Progress

RQ3 Summary: Independent of gender, our findings reveal a significant decrease in student performance from the before-pandemic year to the after-pandemic year. Therefore, we argue too, independent **gender**, that the pandemic impact on student performance does not last long.

RQ4 Summary: The results for open-ended **questions** suggest the same consistent changes in participant grades over the years compared to closed questions. Decrease from 2019 to 2022 and improve from 2022 to 2023.

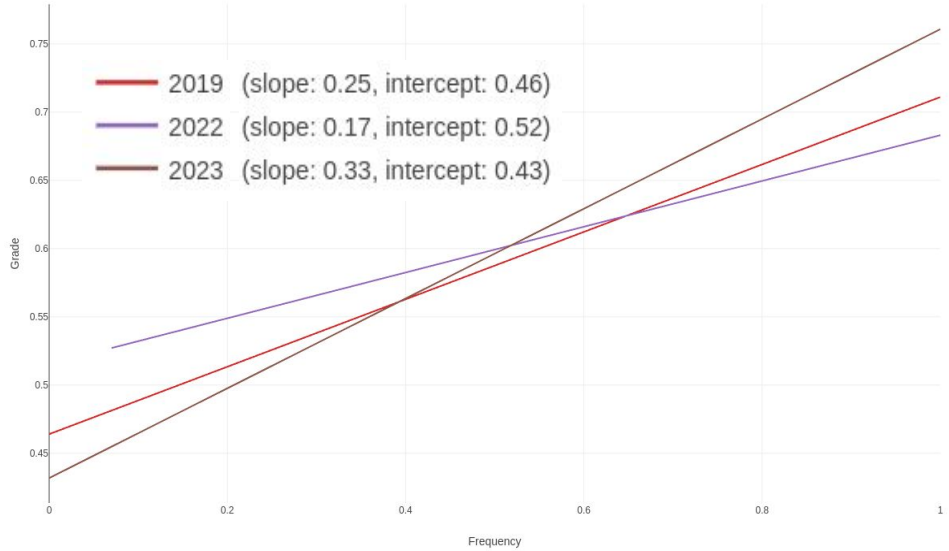
Specific Results In Progress

Topics

Parameter	Design with UML	Implementa-tion	SE Introduction	Software Architecture	Software Processes and Agile Methods	Software Requirements and Use Cases	Software Testing and Quality
2019 Mean	0.7	0.7	0.66	0.65	0.66	0.69	0.49
2022 Mean	0.64	0.67	0.6	0.74	0.74	0.63	0.4
2023 Mean	0.64	0.73	0.66	0.71	0.82	0.75	0.56
p-value (2019 vs 2022)	0.076	0.438	0.242	0.104	0.012 (↓)	0.033 (↓)	0.017 (↓)
p-value (2022 vs 2023)	0.95	0.056	0.273	0.558	0.039 (↑)	0.00001 (↑)	0.00001 (↑)
p-value (2019 vs 2023)	0.101	0.413	0.896	0.321	0.0002 (↑)	0.012 (↑)	0.132

Specific Results In Progress

Frequency vs Grades



Conclusion

- Pandemic affected the student performance in general and specific away
  - The except is in some topics

- Future Works
  - Survey with students and/or professors
  - Analyse others universities
  - Approach others disrupt moments