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Storytelling with Data as an Active Learning Tool for C++ Programming

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***Abstract*— This study examines how second-year mechanical engineering students are taught C++ programming using the active learning strategy "Storytelling with Data. Teaching a programming language to mechanical students in their second year was difficult, especially for the direct second-year students who were not familiar with C++ programming. " 50% of students struggled on the post-unit test using previous techniques. The new method required students to write topic-based descriptions that included justifications, programs, charts, and graphics. These were turned into videos using mobile devices, and app.yoodli.ai was used to assess them for linguistic elements such as weaker words, filter words, inclusiveness, voice quality, and grammar. According to analysis, 80% of the students scored between 12 and 17 out of 20 on the quiz. To determine the statistical significance, a paired t-test can be used. The p-value (0.01844) is smaller than the set significance level (0.05). As a result, you can reject the null hypothesis. This shows that there is a statistically significant difference in student performance before and after utilizing the "Storytelling with Data" approach. Feedback emphasized the method's beneficial effects on participation, group cooperation, and conceptual understanding. This study shows how "Storytelling with Data" can improve C++ programming instruction, address issues, and promote interactive learning, which improves academic performance and comprehension.**

***Keywords*— Storytelling; Computer programming; Pedagogy; Learning environment, Teaching practices.**

I. INTRODUCTION

eaching programming languages like C++ to engineering students in the context of present education, particularly those pursuing students like mechanical engineering, has a challenging problem. The complex nature of coding languages and the abstract ideas present in programming frequently present barriers to students' thorough comprehension and efficient application. For mechanical engineering students to be successful in their future professional endeavors, they must overcome these obstacles.

The goal of this research study is to investigate the "Storytelling with Data" instructional strategy and how it might be used to teach C++ programming to second-year mechanical engineering students. In essence, this strategy involves moving away from conventional teaching techniques and adopting a more immersive and engaging approach. Students are urged to gain a deeper knowledge of programming principles through context rather than only memorizing syntax by heart.

The "Storytelling with Data" approach encourages students to write in-depth descriptions of programming-related topics. The examples include meaningful real-world applications as well as written explanations and code executions, together with visually appealing features like charts and graphs. This method differs from others since it makes use of multimedia tools and has students turn their descriptions into videos. This use of multimedia promotes understanding by presenting the information in a variety of ways, which is in line with the desires of today's tech-savvy age.

While traditional educational methods such as quizzes and activities are used, this study examines how second-year mechanical engineering students are taught C++ programming using the active learning strategy "Storytelling with Data. Teaching a programming language to mechanical students in their second year was difficult, especially for the direct second-year students who were not familiar with C++ programming. " 50% of students struggled on the post-unit test using previous techniques. The new method required students to write topic-based descriptions that included justifications, programs, charts, and graphics. These were turned into videos using mobile devices, and app.yoodli.ai was used to assess them for linguistic elements such as weaker words, filter words, inclusiveness, voice quality, and grammar. According to the analysis, 80% of the students scored between 12 and 17 out of 20 on the quiz. To determine the statistical significance a paired t-test can be used. The p-value (0.01844) is smaller than the set significance level (0.05). As a result, you can reject the null hypothesis. This shows that there is a statistically significant difference in student performance before and after utilizing the "Storytelling with Data" approach. Feedback emphasized the method's beneficial effects on participation, group cooperation, and conceptual understanding. This study shows how "Storytelling with Data" can improve C++ programming instruction, address issues, and promote interactive learning, which improves academic performance and comprehension. While problem-based problem-solving, and reciprocal teaching have their uses, they can fall short of meeting the different learning styles and preferences of today's students. This is the

possible benefit of "Storytelling with Data." This strategy taps into students' creativity and intrinsic drive by encouraging them to create descriptions and movies. Furthermore, the analysis of these films via the app.yoodli.ai application allows for a thorough evaluation of linguistic nuances, allowing educators to provide tailored and constructive criticism for growth.

A. Inspiration for the Study

The significance of this research extends to its congruence with students' demands for a more engaging and inclusive learning experience. The challenge typically encountered in designing programs based on supplied inputs and learning core programming principles can be substantially alleviated by this immersive technique. As we go further into this article, we will highlight the virtues of "Storytelling with Data" over traditional techniques and investigate how it stands to increase engagement, promote collaborative learning, and build a deeper grasp of programming principles among mechanical engineering students.

Finally, the incorporation of "Storytelling with Data" as a novel educational tool shows great promise for teaching C++ programming to mechanical engineering students. This paper intends to shed light on the intricacies of this method, emphasizing its potential to revolutionize the educational landscape and better prepare students for success in the dynamic fields of programming and mechanical engineering.

II. LITERATURE REVIEW

The summary of the research articles is explained in this section, which also acknowledges the lack of application of contemporary methods in teaching and learning.

Isabella A. et. al. (2021) evaluates the developing pedagogical practice of storytelling and its impact on a US school's learning environment. The school has merged imaginary and nonfictional worlds to improve learning for both students and teachers. Through interviews with 11 educational personnel and 79 students, as well as 10 days of classroom observation, the study establishes a theory of storified pedagogy. The introduction of storytelling inside physical learning environments and instructional practices is found to increase pedagogy, reduce student misconduct, empower students through tale morals and transportation, and transform classrooms into individualized learning spaces. This method ultimately improves the overall school experience and promotes students' academic performance. Manwani & Guruprasad, (2022) investigates the ongoing role of narrative in education in the face of changing teaching approaches. Through a survey of educators and students, it analyzes global applications of storytelling in digital education, describing its benefits and problems. The study emphasizes storytelling's ability to transcend the digital divide and suggests ways for cultivating a storytelling culture, eventually emphasizing its benefits for student learning. Clarke, (2017) investigates the use of Instructional Digital Storytelling (IDS) in education as a technology-enhanced method linked with the TPACK paradigm. It includes a narrative inquiry into secondary school teachers' experiences utilizing IDS for instructional purposes, highlighting challenges, benefits, and community development across topics. The research focuses on the process of developing a successful IDS, overcoming obstacles, communicating with students, and recognizing emergent themes. Sugiyama, (2017) This study challenges the assumption of teaching is rare in hunter-gatherer tribes by concentrating on the ostensive form of knowledge transfer. Unlike past studies limited to Western pedagogical conceptions, this research identifies natural pedagogy in human communication, using ostensive indicators including eye contact and pointing. Oral storytelling in forager societies is revealed to incorporate educational components, communicating generalizable ecological and social knowledge through ostensive behaviors. Jarrett, (2019) Storytelling's crucial function in human knowledge development is often overlooked. While formal education may ignore its worth due to creativity limits, this essay underlines that storytelling can encourage and interest learners, even the reluctant ones. It introduces four storytelling modes (oral, written, graphic, and touch) as techniques to boost material engagement, facilitate classroom debate, and promote critical reflection in professional development. Landrum et al., (2019) Stories have been used as teaching tools throughout human history, yet their pedagogical value is sometimes underrated. By examining various methods and outlining the value of storytelling in education, this theory study emphasizes the connection between teaching and storytelling. It gives suggestions and warnings for psychology instructors who wish to use storytelling as a strategic pedagogical technique for improved student engagement and academic results. Bryant, (2023) The research suggests a pedagogical transformation by predicting and incorporating upcoming student experiences that include components of transition, uncertainty, and belonging. This strategy uses digital storytelling to go beyond survey metrics to develop a dynamic, interconnected community across multiple life dimensions. The paper describes an ethnographic-style model for co-design and curriculum enhancement using semi-structured digital storytelling, as demonstrated through participatory action research case studies at the University of Sydney Business School and the London School of Economics, effectively integrating student experiences into curriculum and assessment co-design. Chavan et al., (2023) In response to the problems faced by recent pandemics, engineering education has adopted design thinking to improve remote learner engagement and practical problem-solving abilities. This change from traditional teaching methods to new approaches like design thinking addresses the need for active, collaborative learning, particularly in complicated areas like metrology. The research describes the effective adoption of design thinking in a metrology course for third-year mechanical engineering students, which resulted in enhanced learning coefficients, course results, and student enjoyment of interactive learning possibilities. Choo et al., (2020) This study compares traditional oral storytelling, which has been passed down through generations, to current digital storytelling, which incorporates multimedia aspects. The study dives into technological contrasts, storyteller roles, process vs. product focus, and audience involvement. The review stresses digital storytelling as a fusion of art and technology and explores empirical evidence supporting its potential to improve teachers' and students' knowledge and learning experiences, recommending

its application in education while identifying future research options.

III. METHOD

A. Participants

The study took place at Rajarambapu Institute of Technology in Rajaramnagar, Sangli, Maharashtra. The observations were conducted with a total of 67 students enrolled in a fourth-semester computer programming course in C++.

In another case, the faculty discussed all the phases that indicated how the storytelling activity flowed.

1) **Select a Concept and Write a Description**
   Select an idea or subject that relates to the readings for the C++ course. Write a thorough explanation of the idea that includes definitions, applications, examples, and important aspects.
2) Make an interactive video that includes a plot, visual coding, charts, diagrams, sounds, and so on. Add it to Moodle so that students can view it.
3) **Video Evaluation:**
   Use artificial intelligence (AI) tools such as Yoodli (https://app.yoodli.ai/) to evaluate the video impact. Sentiment analysis, measuring explanation clarity, or determining engagement levels are a few examples of this. Utilize the knowledge to improve upcoming videos or instructional strategies.
4) **Evaluate topic comprehension and logical improvement using quizzes**
   Create tests based on the idea presented in the video. These tests ought to evaluate students' comprehension of the subject matter. Make use of a variety of question formats (such as multiple-choice, fill-in-the-blanks, etc.) to reliably assess comprehension levels.
5) **Paired t-test to determine whether the improvement is statistically significant or not.**
   Conduct a paired t-test to analyze whether the video presentation significantly improved students' understanding. Compare pre-video quiz scores with post-video quiz scores to determine if there is a statistically significant improvement in comprehension.
6) **Feedback from students**
   To determine whether the video presentation significantly increased students' understanding, administer a paired t-test. To ascertain whether comprehension has improved statistically significantly, compare the pre-video and post-video quiz scores.
7) **Result and Discussion**
   Gather and examine the information from the surveys, statistical analysis, artificial intelligence (AI) technologies, and student comments. Talk about the findings, including any statistically significant gains in comprehension, the video's advantages and disadvantages, and any areas where instructional strategies or video material could be improved.

B. Procedure

1) Select a Concept and Write a Narrative

Students were assigned various themes in our classroom approach, and they began constructing their descriptions that included explanations, codes, charts, visuals, and more. As shown in Fig. 1.

Fig. 1. Students writing stories in the classroom.

2) Students prepare an interactive video that includes a plot, visual coding, charts, diagrams, sounds, and so on, and post it to Moodle.

Equipped with their imaginative descriptions, students used their phones' video capabilities to create appealing videos. All the students submitted their videos on Moodle as shown in Fig. 2.

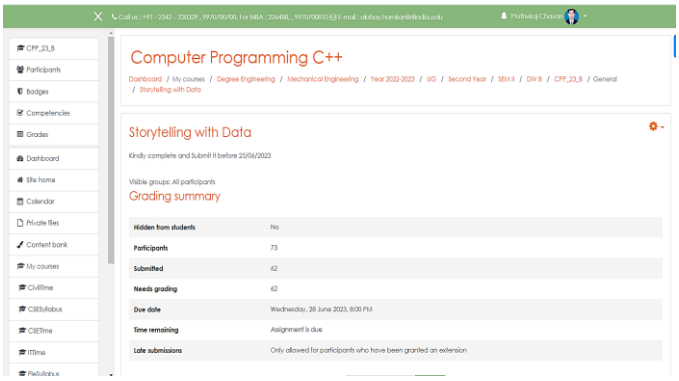

Fig. 2. Students submitted their Videos on Moodle

Following that, the videos were accurately examined utilizing the app.yoodli.ai program as shown in Fig. 3. This complete analysis included identifying weak words, filter words, non-inclusive language, voice quality, and grammatical problems. The students were then given the report that resulted from this in-depth analysis. This cyclical process of invention, recording, and analysis not only sharpened their technical skills but also provided them with useful feedback to improve their storytelling and communication abilities. This comprehensive evaluation not only enhanced their technological competence but also educated their language grace, allowing for an experienced improvement of their communication skills. Snapshot of app.yoodli.ai Fig. 4.

Fig. 3 Video Preparation using app.yoodli.ai

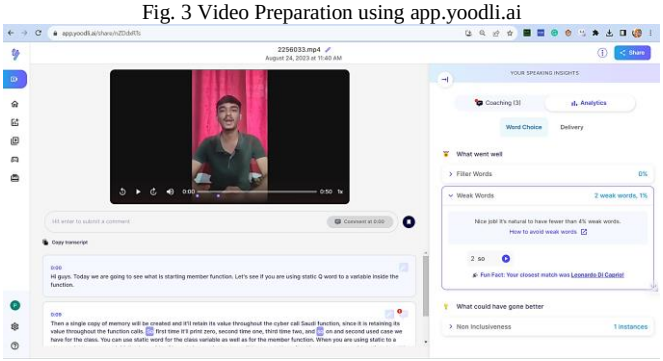

Fig. 4. Snapshot of app.yoodli.ai

IV. RESULTS

The following approaches were used to help achieve the intended goals in implementing the "Storytelling with Data" strategy for increased comprehension and engagement:

A. Scrutiny of student feedback responses:

An assessment of student feedback responses was done, acting as a basic aspect in measuring the effectiveness of the "Storytelling with Data" approach. By diving into student reactions, insights were gathered into the method's impact on their learning experiences and perceptions. Fig. 5 shown the feedback from the students.

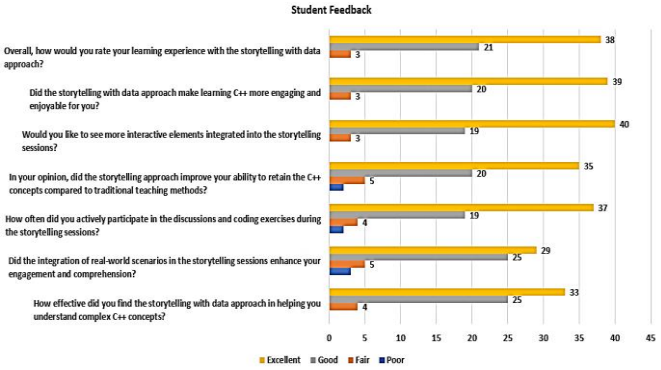

Fig. 5. Feedback from the students

B. Execution of a paired t-test

A paired t-test was used to carefully evaluate the effect of the "Storytelling with Data" strategy on student performance. The purpose of this statistical analysis method is to determine if the observed performance variations between two sets of data are due to random variation or statistically significant differences.

The process involved comparing the average performance ratings of two groups: UT1 (15), which represented the group before the "Storytelling with Data" technique was implemented, and UT2, which represented the group after it had been integrated. The significance level (alpha), a standard cutoff used in research to evaluate statistical significance, was chosen at 0.05.

The following were the findings of the paired t-test analysis:

The null hypothesis (H0), which was developed, claims that there is no noticeable difference between the performance averages of UT1 (15) and UT2(15). The null hypothesis was rejected, though, because the p-value was less than 0.05 (0.01844). This indicates a statistically significant gap in performance between the two groups.

- The estimated p-value of 0.01844 shows that, at 1.84%, there is very little chance of making a type I error (rejecting a true null hypothesis). Stronger proof in favor of the alternative hypothesis (H1) is presented by a lower p-value.
- It was determined that the test statistic (T) was -2.3863 and that it was outside the 95% confidence interval's acceptable range of -1.9781 to 1.9781. Also outside the acceptability interval was the computed difference between the sample averages, x1-x2=-1.3. The test statistic was computed using the difference's standard deviation (S'), which was 0.547.
- The measured effect size (d) was 0.41, which indicates a moderate difference between the mean performance scores. This suggests that the "Storytelling with Data" method had an important influence on the students' performance.

In conclusion, the paired t-test outcomes highlighted the statistical significance of the variation in student performance between the use of the "Storytelling with Data" strategy and the control group. The addition of effect size assessment highlighted the difference's practical importance even more.

C. Quiz

Furthermore, a new quiz component was included, which coincided with a significant improvement in student performance. Fig. 6. Shows that 80% of the participants achieved scores ranging from 12 to 17 out of a possible 20. Furthermore, a comparison of the unit test and final examination results revealed a perceptible improvement in the domain of C++ programming. This modification in assessment methods appears to have had a good impact on students' results as well as a more comprehensive understanding of the subject matter.

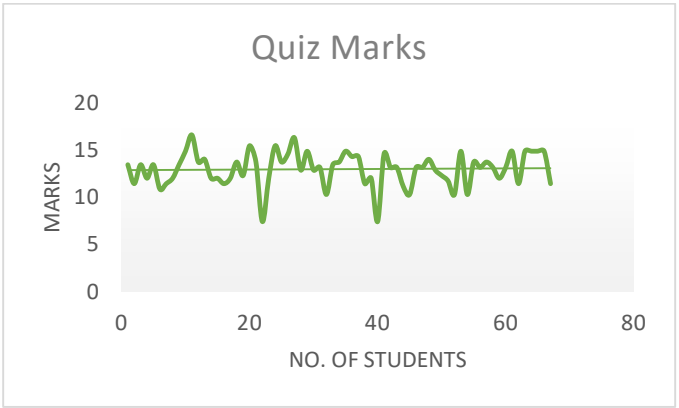

Fig. 6. Quiz score

V. CONCLUSION

In conclusion, including the "Storytelling with Data" methodology into the C++ programming curriculum for second-year mechanical engineering students was a game-changing development. The assessment process was enhanced by using app.yoodli.ai for language analysis, which looked at things like weaker words, filter words, inclusiveness, voice quality, and grammar in student-recorded videos.

- The assessment results showed that this project had achieved some amazing benefits. On the quiz, an impressive 80% of pupils showed considerable improvement, earning marks between 12 and 17 out of 20.
- The estimated p-value of 0.01844 supported the performance difference's statistical significance. The outcomes strengthened the alternative hypothesis (H1) because there was only a 1.84% risk of making a type I mistake.
- The derived test statistic (T), which was -2.3863 and above the permissible range within the 95% confidence interval, further highlighted the magnitude of the observed discrepancy. This conclusion was supported by the estimated difference between sample averages (x1-x2=-1.3). The "Storytelling with Data" method had a significant impact on students' outcomes, as evidenced by the effect size (d) of 0.41, which indicated a moderate difference between mean performance scores.
- This method is used to increase the effectiveness of instructional activities and spark students' interest in programming languages like C++. Its goal is to spark students' curiosity so they may learn more and advance their programming skills rather than to assess how well they are doing at programming.
- Additionally, evaluations from students were crucial in determining how beneficial the strategy was. A complex knowledge of the approach's impact on students' learning experiences and views was revealed by probing their responses. A thorough knowledge of the major impact the "Storytelling with Data" approach exerted on student performance resulted from the integration of quantitative analysis, effect size assessment, and qualitative feedback.

In essence, our study has revealed a fruitful pedagogical route for improving programming education. The combination of interactive methods, language evaluation, and thorough feedback mechanisms paves the way for further improvements in efficient teaching methods for difficult technical subjects like C++ programming.

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