Case Study-Based Learning Pedagogy to Teach Advances in Programming Languages

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Abstract. Programming language (PL) is a tool programmers use to convert their logic to software programs. Day by day new programming languages are becoming popular. It is not easy to teach all types of languages in one course. Case study-based learning is a pedagogy that implements learning one subject collaboratively with peers having expertise in the same topic but with different perspectives. Case study-based learning it ages learners to collect information about the topic, share their knowledge/views with team members and decide the action points, consider the challenges, and choose the best solution.
This work explores Case study-based Learning pedagogy to teach advances in programming languages. It is implemented for students of engineering college. This paper addresses the process to implement Case study-based learning pedagogy. The paper also analyzes the effect of implementing this pedagogy for teaching different programming languages used in Application development.

Keywords: Case Study, Collaborative Learning, Pedagogy, Programming Languages

1 Introduction

In his social science research on family budgets, Frederic Le Play first used the case-study approach in 1829 as a handmaiden to statistics. Le Play's techniques were used by sociologists, psychologists, anthropologists, and others to test their own theories and hypotheses before publishing the findings [1]. One example of such work is the well-known Grounded Theory paper written by sociologists Barney Glaser and Anselm Strauss.
Case studies had been employed as instructional techniques for creating new ideas and hypotheses by the late 1920s. The case study method has been used by Harvard Business School to instruct management courses since 1921. Industrialists started to consider using the case study at the turn of the 20th century to create their own ideas about productivity, production, supply chains, and other topics. Initially, academics used this method to draw reliable conclusions from events or particular cases.

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Nowadays Case study is used as an innovative pedagogy to teach students over traditional class teaching. Education, and specifically educational evaluation, is one of the fields where case studies have recently gained appeal. Case study-based learning techniques include problem-based learning, role-playing, and case-based learning. It is a simple tool to understand the case. Case study enhances the experiential learning approaches for improving students' learning experience. A case study is a student-centric activity. It may be done by a single student (researcher) or in a small group of students [2]. The paper proposed case study-based learning for different programming languages used for application development. In the technical world of software, there is a huge rise in the industry which leads to an increase in programming languages. As per the history of programming languages information currently, there are more than 8900 programming languages available every year, a number of programming languages are created, described, and put into practice in order to stay up with the evolving hardware, software, and programming paradigms. Out of these 8945 languages though few are very popular and in use today.

2 Literature Review

Case studies have been used for a long time in business, legal, medical, and social science schools, but they can be used in any area when teachers want students to consider how what they have studied pertains to real-world scenarios [4]. An alternative to non-traditional authentic assessment is case-based learning, which enables students to apply their knowledge to actual situations and so fosters higher levels of cognition. Case-based learning involves guided inquiry and is grounded in constructivism whereby students form new meanings by interacting with their knowledge and the environment [13]. The case study teaching method is a highly adaptable style of teaching that involves problem-based learning and promotes the development of analytical skills [14]. By presenting content in the format of a narrative accompanied by questions and activities that promote group discussion and solving of complex problems, case studies facilitate the development of the higher levels of Bloom's taxonomy of cognitive learning; moving beyond recall of knowledge to analysis, evaluation, and application [15,17]. Similarly, case studies facilitate interdisciplinary learning and can be used to highlight connections between specific academic topics and real-world societal issues and applications [16, 17]. This has been reported to increase student motivation to participate in classroom activities, facilitate learning, and improve assessment performance [18 – 22] According to Yin, case studies can be used to explain, describe, or study events and phenomena in the everyday context of new policy. Describe the pathways resulting from the initiative or service development [3, 4, 5].

In today's world, many more programming languages are available with different characteristics. In higher education for computer engineering and Information technology, programming languages are a core and essential part of the curriculum. Many researchers have studied the different programming paradigms and programming languages. These languages are divided into different categories based on the platform, operating system, characteristics, features, coding style, tools used

and application development. A few languages are very popular for application development such as Python, Java, JavaScript, C++, Scala, and Kotlin. Table 1 shows the summary of the research work of different programming languages with its pros and cons.

Table 1. Summary of Programming languages with pros and cons.

Ref	Languages Covered	Advantages	Limitations /Disadvantages
[6]	C, C++, Java, C#, LISP, Scheme, ML, Haskell.	Covered the importance of having programming languages in the curriculum. Discussed recommendations for PL.	Not covered all programming languages.
[7]	C++, Perl, Lisp and java.	Discussed criteria to compare programming languages. Discussed criteria for the goodness of the language.	Language-wise code is not discussed in detail.
[8]	PHP and ASP.NET	The WAPT tool is used to provide an environment for loading and performance testing of websites and applications.	Parameters in results are not discussed in detail. Not discussed when to go for which scripting language depending on the applications
[9]	C, C++, Java, swift, C#, F#, VB.NET, JavaScript.	Discuss cross-platform languages for application development	Not given
[10]	Java, Android Kotlin	Discussed features of Kotlin, such as it as ability to extend classes, Null Safety, lazy loading and, fewer lines of code.	For the beginner Kotlin may be difficult.
[11]	Swift, Java, Kotlin	Discusses features of the iOS operating system, Java, and Android applications.	Java will not be compatible well with iOS applications. The significance of the design part from Android is not discussed.
[12]	Various programming languages	Discussed Paradigms used by mentioned languages. Provided analysis of different paradigms using Paradigmatic scale and semantics with results.	Discussed the criteria for the realization of programming paradigms.

The programming languages were taught to students in traditional ways. It is observed that it's very difficult to teach all the languages at once. It's also very difficult to choose the appropriate one according to the application's needs. In this paper, we proposed a case study-based learning to teach more than 16 programming languages

which helps students to choose the appropriate programming language based on the application requirements.

3 Methodology

Normally programming languages were taught to students in traditional ways. Case Study pedagogy was implemented to teach the core subject Programming Paradigm for the Second Year B. Tech. students. In the Programming Paradigm course, the last unit is based on Advances in programming. To give an overview of all recent programming languages we decided to use case study pedagogy. Case study - active learning method is used to make the teaching interactive, increase student participation and learning. The case study method implants the meta capabilities in students. Fig.1 shows the Case Study based learning model.

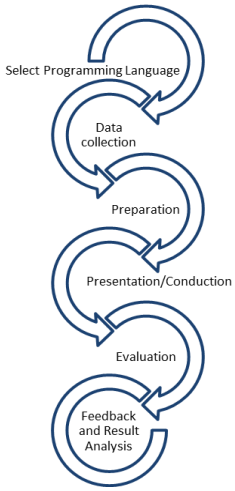

Fig. 1. Case Study implementation for Programming Languages

The Case study activity is conducted in following steps

1. Select Programming Language:
   Student teams were formed. In order to study a specific language, each group selected a programming language of their choice. 16 languages selected by groups are: Elm, Rust, Kotlin, GO, Ruby, Scala, Swift, R, C#, PHP, Java Script, Groovy, Ruby on Rails, Perl, OpenGL and HTML/DHTML.
2. Data collection
   Each team gathered the data related to the points such as Development Details like, Latest version, Paradigm, Type of Language: (High/low), compiled/Interpreted, Open source/ License, Dependency (Machine/Platform), Performance (Compilation time /Execution time), Flexibility, Efficiency(speed), Security, Usage, Integrity,

Application (3-4), Tools/API's, Comparison with other languages and Features, Advantages, Disadvantages

3. Preparation:
   In the Preparation stage, Students read the gathered information in advance, understand, and Identify the key issues. The Collaboration and reflection of information with teammates/Peers. Discuss the understanding about the PL, Key Issues, prioritize the data, highlight and decide the data for presentation. Finally, the team prepares the Presentation.

4. Presentation Delivery
   In the presentation stage, we have prepared the timetable such that each lecture will contain 4 case study presentation of 15 minutes each. Students enthusiastically participate in the case study activity. They came up with excellent material and presented it in a very well manner to their subordinates. Through-out this activity, faculty members were there to guide them from where to collect the material, how to arrange it properly and finally how to present it. Fig. 2 shows case study presentation activity.

Fig. 2. Case Study Presentation

5. Evaluation: Evaluation is conducted in the paper pencil format.
6. Feedback and Analysis: We analyzed the results of 2021-22 batch students without case study implementation and 2022-23 batch students with case study implementation. We have also collected feedback in the form of google from the students. Which will be discussed in the next section.

4 Result and Discussion

Based on the case study presentation, we have conducted a quiz. Table 2 shows questions from the quiz.

Table 2: Quiz based on the case study

Q. No.	Question

1	Which language is highly used to design user facing applications like web browser engine?
2	Applications for online shopping having features like like website hosting, payment integration, Content Management System, a store with plugins and extensions etc. uses _____ language.
3	To design mobile applications which language can be used?
4	Feature(s) of Scala language is/are …..
5	Which language(s) are used to design web applications?

Fig. 3 shows the result of the quiz

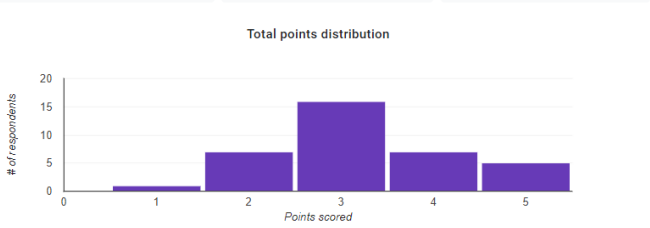

Fig. 3. Quiz Result

Following Fig. 4 shows feedback of the students about the experience of this activity.

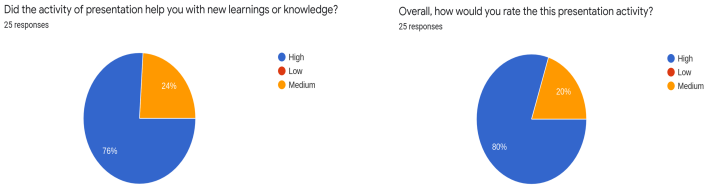

Fig. 4. Students experience feedback

In 2021-22, we used traditional teaching method and in 2022-23 we applied case-study based teaching method to teach Unit -6 Advances in Programming Languages. In End Semester Examination (ESE), we included a question on this topic

for the 10 Marks. Table 3 data represents, number of students who scored < 50 %, between 50% to 80% and >80 % marks. This represents the students overall academic performance for the course.

Table 3: No. of Students scored marks (Observed Values)

	<50%	50% to 70%	>80% to 100%
2021-22	17	97	124
2022-23	9	38	170

We compared the results of two batches with the help of Chi Square test to understand the improvement in the learning of the students. Chi Square test is a non-parametric test for hypothesis testing for categorical data. Chi-squared test for one-way classification is used to test the results. There are four steps as shown below.

Step 1: Define Hypothesis:

H_0: Null Hypothesis: Students performance is equal over years.

H_a: Alternative hypothesis: Performance is increasing over years.

Step 2: Calculate the expected value:

$$Expected\ Value\ (E) = \frac{(Row\ Total)*(Column\ Total)}{Total\ Number\ of\ Observations} \quad (1)$$

Table 4 shows the expected values.

Table 4: Calculation of Expected Values for each cell

	<50%	50% to 70%	>80% to 100%
2021-22	13.6	70.62	153.78
2022-23	12.4	64.38	140.22

Step 3: Calculate $(O-E)^2 / E$ for Each Cell in the Table where O = Observed value and E = Expected value. Table 5 shows the result of this calculation.

Table 5: Calculation of $(O-E)^2 / E$ for each cell

	<50%	50% to 70%	>80% to 100%
2021-22	0.85	9.86	5.77
2022-23	0.93	10.81	6.33

Step 4: Calculate the Test Statistic x^2

$$x^2 = \sum \frac{(O-E)^2}{E} \quad (2)$$

Calculated value is $x^2 = 34.54$

The degrees of freedom in this case equals the number of columns in the table minus one multiplied by the number of rows in the table minus one, or (r-1) * (c-1). In our case it is (2-1) * (3-1) = 2. Finally, compare the obtained statistics with the critical value in the chi-square table. As you can see, for an alpha level of 0.05 and two degrees of freedom, the critical value in the table is 5.991, which is less than the obtained statistic of 34.54. The computed chi-square value is greater than the critical value, so the null hypothesis is rejected. This means finally accepting the alternative hypothesis. According to the alternative hypothesis, the results show improved performance when the course includes case study implementation. This will ultimately help them develop their skills.

5 Conclusion

To teach advances in programming languages and to introduce students to the features of various languages and their applications, we applied case study pedagogy technique. We evaluated the effect of this technique on the learning by the students with the help of feedback and grades in course. We can say that results have been improved with case study technique. This technique excels the active learning, collaborative learning and Meta skills-critical thinking of the students.

References

1. Britannica, The Editors of Encyclopaedia. "Frédéric Le Play". *Encyclopedia Britannica*, 7 Apr. 2022, https://www.britannica.com/biography/Frederic-Le-Play. Accessed 2023/03/27.
2. Patricia A. Duff Case Study Research on Language Learning and Use , Annual Review of Applied Linguistics,34, 1–23 , Cambridge University Press,(2014)
3. Sarah Crowe, Kathrin Cresswell,Ann Robertson, Guro Huby3 Anthony Avery, and Aziz Sheikh The case study approach. Crowe et al. BMC Medical Research Methodology ,11: 100,(2011)
4. Nurulwahida Azid, Ridzuan Hashim, Tee Tze Kiong & Yee Mei Heong Malaysia and China Students' Feedback on the Implementation of Critical Thinking Pedagogy: A Case Study International Journal of Advanced Science and Technology Vol. 29, No. 3, 227-237 , (2020)
5. Omar Rabeea Mahdi, Islam A. Nassar & Hashem Ali Issa Almuslamani The Role of Using Case Studies Method in Improving Students' Critical Thinking Skills in Higher Education International Journal of Higher Education Vol. 9, No. 2; 297-308 (2020)

6. Kim Bruce, Stephen N. Freund Programming Languages as Part of Core Computer Science, SIGPLAN Workshop on Programming Language Curriculum, Cambridge, Massachusetts, USA May 29–30,(2008)
7. Prashant Kulkarni, Kailash H D, Vaibhav Shankar, Shashi Nagarajan, Goutham D L Programming Languages: A Comparative Study ,Computer Science,India.
8. Ogunrinde Mutiat Adebukola, Olorisade Babatunde Kazeem .Performance Comparison of dynamic Web scripting Language: A case Study of PHP and ASP.NET, International Journal of Scientific & Engineering Research, Volume 5, Issue 7, 78-89,(2014)
9. Boppuru R. P Operating Systems for Mobiles until late 2018: A Comparative Survey and Overview, International Journal of Computer Sciences and Engineering, Vol.-6, Issue-12, 576-581,(2018)
10. Subham Bose,Aditi Kundu,Madhuleena Mukherjee,Madhurima Banerjee. A Comparative Study: Java Vs Kotlin Programming In Android Application Development, International Journal of Advanced Research in Computer Science , Volume 9, No. 3,41-45,(2018)
11. Mohanad Ali Meteab Al-Obaidi , Yasmin Makki Mohialden , Muna Abdul Hussain Radhi , and Noor abdallah othman.A Comparative study of Android and iPhone Operating System main languages, Solid State Technology,Volume: 63 Issue: 6 (2020)
12. Lidia Gorodnyaya. Method of Paradigmatic Analysis of Programming Languages and Systems, CEUR-WS.org/Vol -2543 , 149-158],(2020)
13. Lee, V. What is Inquiry-Guided Learning? New Directions for Learning, 129, 5-14. (2012)
14. Herreid, C. F., Schiller, N. A., Herreid, K. F., & Wright, C. In case you are interested: Results of a survey of case study teachers. Journal of College Science Teaching, 40(4), 76–80. (2011)
15. Anderson, L. W. & Krathwohl, D. A taxonomy for learning, teaching, and assessing: a revision of bloom's taxonomy of educational objectives, Complete edition. Longman Publishing Group: White Plains, New York. (2000)
16. Bonney, K. M. An Argument and Plan for Promoting the Teaching and Learning of Neglected Tropical Diseases. Journal of Microbiology & Biology Education, 14(2), 183–188. https://doi.org/10.1128/jmbe.v14i2.631 (2013)
17. Herreid, C. F.. Start with a Story: The Case Study Method of Teaching College Science, edited by Clyde Freeman Herreid. Originally published in 2006 by the National Science Teachers Association (NSTA); reprinted by the National Center for Case Study Teaching in Science (NCCSTS) (2013).
18. Flynn, A. E. & Klein, J. D. The influence of discussion groups in a case-based learning environment. Educ Tech Res Dev, 49(3), 71–86. (2001).
19. Murray-Nseula, M. Incorporating case studies into an undergraduate genetics course. Journal of School Teaching and Learning; 11(3),75–85. (2011).
20. Pintrich, P. R. & Schunk, D. H. Motivation in education: theory, research, and applications. Merrill Prentice-Hall: Upper Saddle River. (2002).
21. Yadav, A., Deschryver, M., Dirkin, K., Schiller, N. A., Maier, K., & Herreid, C. F. Teaching science with case studies: A national survey of faculty perceptions of the benefits and challenges of using cases. Journal of College Science Teaching, 37(1), 34–38. (2007).
22. Dr Chhaya Gosavi ,Dr. S. Arora, Active Learning Strategies for Engaging Students in Higher Education, Journal of Engineering Education Transformations (JEET) Month 2015, ISSN 2349-2473, eISSN 2394-1707