Journal of Engineering Education Transformations ,
Volume 32 , No. 1, July 2018, ISSN 2349-2473, eISSN 2394-1707

Active Learning Approach for Python Programming

Namratha M[1], Rekha G.S[2], Syed Akram[3], Selva Kumar S[4], Jyothi S Nayak[5]
[1,2,3,4,5] Department of Computer Science & Engineering, B.M.S. College of Engineering, Banaglore
[1] namratham.cse@bmsce.ac.in
[2] rekhags.cse@bmsce.ac.in
[3] syedakram.cse@bmsce.ac.in
[4] selva.cse@bmsce.ac.in
[5] jyothinayak.cse@bmsce.ac.in

Abstract: In Outcome-Based Education, Active Learning methodology is used to improve the learning of the students in the classroom. To enhance the project implementation skill of the students, one of the Comprehensive Courses was introduced namely "Programming in Python" for the undergraduate students of Department of Computer Science & Engineering. In this course, students carry out a project on the concepts learned during the course. Active learning introduced in this course, helped the students to engage in the implementation of projects, weekly reviews, and discussion with peers to implement the concepts learned in the classroom. The active learning framework helped the faculties to review and evaluate the project work. The outcome of active learning helped the students to solve the problems with project techniques than learning programming construct.

Keywords : Comprehensive Course, Rubrics, Self-Study, Active Learning

Namratha M
Department of Computer Science & Engineering,
B.M.S. College of Engineering, Banaglore
namratham.cse@bmsce.ac.in

1. Introduction

The current trend demands the use of Outcome Based Learning (OBL) to enhance the education quality. In order to accommodate OBL, the course has been designed to assist the interaction among students which provides an effective method to maximize their learning with active participation. Active learning through the project is one of the efficient and commonly used techniques to promote OBL. The course is designed to provide ample time apart from the contact hours to develop projects based on the concepts learned inside the classroom. During the development of the project, students have taken inputs from the alumni/Industry Experts [1].

Incorporating Project Based Learning(PBL)[2] methods in project development has helped the students to imbibe active learning in an efficient manner. The advantages of PBL is to provide a required learning atmosphere and also develop project[3]. The challenges faced during the implementation of PBL are discussed by Marilyn et.al [4]. Monitoring the progress of projects through proper communication with the students is more important than developing evaluation rubrics. The key to success of imbibing active learning is adapting the old strategies to your needs and creating your own strategy [5][6][7][8].

Student learning has been enhanced through the implementation of theoretical concepts learned by them. The students can enhance their learning

experience by developing real-time applications based on the theoretical concepts learned. The learning can happen inside the classroom, laboratory, discussion with peers or faculties and more importantly self-learning.

In this paper, the design and assessment plans for the course "Programming in Python" is discussed. The decision to include self-study component in the comprehensive course was very new to most of the faculties. In each semester, two courses were selected as a comprehensive course with six credits each, of which two credits was for self-study component. It was a continuous journey with regular meetings with all stakeholders on a regular basis before the course started and during the semester. Different departments opted for a different methodology to make use of self-study component but Department of Computer Science & Engineering adopted active learning through projects.

The methodology and plan for the comprehensive course "Programming in Python" have been discussed in Section 2. The evaluation technique adopted for active learning through projects has been discussed in Section 3.

2. Methodology

The faculty shares the plan of activities for the students to carry out their projects for the course "Programming in Python" at the start of the semester.

The main objective was to make the students implement the project's stage by stage during the course. Active learning is the integration of knowing and doing [9].

Student's teams were formed of size ranging from 3-4 members and freedom was given to select the project topic initially. The topic selected had to be a real-time application. This real-time application made them not to download and submit the existing project. Students exposure towards collecting new requirements and design and develop as per the requirements was the main motive.

Reviews given by the faculty helped the students to complete their projects in the right direction and in a timely manner. Along with that, communication and presentation skills of students was enhanced.During the review process, the peers gave additional inputs for further improvements of the project.

A. Plan

Under self-study component of "Programming in Python" course, students had to carry out a project work of developing a Web application or Database Application or Gaming application or Graphics Application to explore the practical applications of the concepts learned. Few projects were also developed for the benefit of department activities.

The plan of activities as shown in Table 1. The activity planned was successfully applied in easy execution of the project. Additionally online quiz was conducted through Social Learning platform Wiksate [10].

Table 1: Project Development Plan Of Activities

Sl. No	Week	Probable Dates	Activity
1	1st	08th to 13th Aug 2016	Formation of groups. Note: Student groups of size 3 or 4 within the same lab batch
2	2nd and 3rd	22nd Aug to 03rd Sep 2016	Project topic selection by each group
3	4th	06th Sep to 13th Sep 2016	Presentation: Student and Project topic introduction by each group
4	5th	19st to 24th Sep 2016	High level Design of the project (Design Layout)
5	6th and 7th	26th Sep to 08th Oct 2016	Presentation on Graphical User Interface of project by each group
6	8th and 9th	13th to 27th Oct 2016	Presentation of Back-end logic of the project by each group (Database Connection, Networking application, Gaming, Data Analytics, Design of table, etc.)
7	10th	28th Oct to 05th Nov 2016	Complete Project Demonstration with Report

3. Programming In Python: Course End Survey And Rubrics For Project Evaluation

Table 2 A depicts Course Outcomes (CO) designed for the "Programming in Python" course. CO5 is designed in order to achieve the higher level Program Outcomes (PO) such as PO9 and PO10 and also the CO-PO Mapping for Programming in Python course are depicted in Table 2B.

The two methods of assessment for computing the CO attainment are direct and indirect

Table 2a: Course Outcomes For Programming In Python

CO1	Demonstrate the salient features of python.
CO2	Illustrate object oriented concepts using python programming.
CO3	Demonstrate database storage and retrieval in python.
CO4	Develop User-interface and graphics applications in python.
CO5	Design and develop interactive applications for a given real world requirements.

Table 2b: Co-po Mapping

CO-PO Mapping												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2		3									
CO2	2		3									
CO3	2	2	3									
CO4	2	2	3									
CO5		2	3	3	2				3	3		

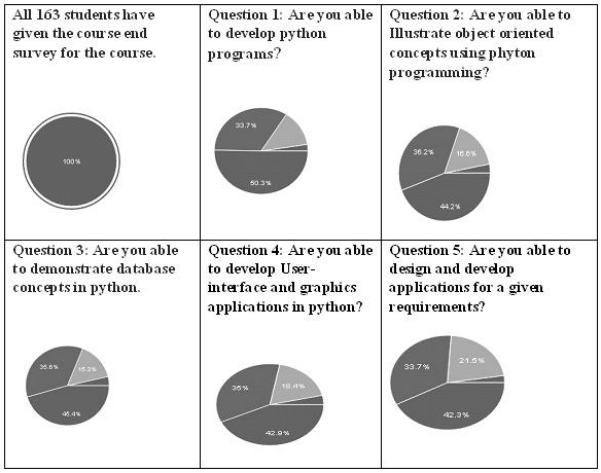
Table 3a: Course End Survey Rubrics

Course Code:15CS5DEPIP	Course Title: Programming in Python			
Criteria	Excellent	Good	Average	Poor
Are you able to develop python programs?	Able to develop python programs on any given concept.	Able to develop python programs on most of the given concepts.	Able to develop python programs on few concepts.	Unable to develop python programs.
Are you able to Illustrate object oriented concepts using python programming.	Able to Illustrate the entire object oriented concepts using python programming.	Able to Illustrate most of the object oriented concepts using python programming.	Able to Illustrate few of the object oriented concepts using python programming.	Unable to Illustrate object oriented concepts using python programming.
Are you able to demonstrate database concepts in python?	Able to demonstrate all the database concepts in python.	Able to demonstrate most of the database concepts in python.	Able to demonstrate few of the database concepts in python.	Unable to demonstrate the database concepts in python.
Are you able to develop User-interface and graphics applications in python?	Able to develop any User-interface and graphics applications in python.	Able to develop most of the User-interface and graphics applications in python.	Able to develop few of the User-interface and graphics applications in python.	Unable to User-interface and graphics applications in python.
Are you able to design and develop applications for a given requirements.	Able to design and develop any applications for a given requirements.	Able to design and develop most of the applications for a given requirements.	Able to design and develop few of the applications for a given requirements.	Unable to design and develop applications.

Table 3b: Course End Survey Results (in %)

Course Outcome	Excellent	Very Good	Good	Satisfactory	Effective Attainment	Attainment
CO1	82	55	22	4	3.32	82.98
CO2	72	59	27	5	3.21	80.37
CO3	74	58	25	6	3.23	80.67
CO4	70	57	30	6	3.17	79.29
CO5	69	55	35	4	3.16	78.99

Table 3c: Course End Survey Results (pie Chart)



· The direct assessment is computed through evaluation of Continuous Internal Evaluation (CIE) which consists of Theory Tests, Quiz/Alternate Assessment Tool (AAT) and Laboratory Component.

· The indirect assessment is done through Course End Survey (CES) at the end of the semester. The CES questions are designed to be mapped to the Course Outcomes and also CES rubrics are framed for evaluation of the indirect assessment as shown in the table 3A.

The results of Course End Survey both in percentage and pie chart are illustrated in table 3B and 3C. From the corresponding CES results it is evident that most of the students have given an "Excellent" rating which in turn reflects that active learning is an efficient method of teaching pedagogy.

Table 4 depicts the rubrics used for evaluation of the Python applications developed by the students. The external examiner was invited to evaluate the projects to maintain fairness and transparency. The quality of education was greatly enhanced through active learning strategy.

The skills of the student were portrayed all through the phases of the project such as planning, designing, implementing and presentation. In order to achieve Program Outcomes (PO) PO7 to PO12 such as lifelong learning, professional practice, and ethics, active learning was introduced as part of self-study.

4. Challenges In Implementing Active Learning Through Projects For Programming In Python

- Following were the challenges faced during implementation of active learning through projects for Programming in Python course:
- Identification of the problem statement which students can understand and implement in stipulated time.
- Assigning Project to the group based on team size.
- Providing required resources (software, materials) to the students for developing projects.
- Aligning the course content to help the student to learn the concepts faster in implementing the project.
- Initially, student found this approach very hectic but based on timely guidance by faculty coordinators they were able to accept the new approach of active learning.

- The class teacher has to provide the inputs or guidance to the entire project groups in a class.

5. Impact Of Active Learning In Python

A. Impact of Active Learning for Python course

The Fig.1 shows the sample questions framed in the internals evaluation and most of the questions were Analyze and Create level of Bloom's Taxonomy [11]. Since active learning was implemented from the beginning of the course, students were able to arrive at appropriate solutions for the given problems. The Fig.2 shows the performance of the students in CIE.

Table 4: Project Evaluation Rubrics

Criteria	Exemplary	Proficient	Partially Proficient	Points
Graphical User Interface (GUI)	(2) The project has an exceptional design, attractive and usable layout.	(1) The project has an attractive design and usable layout	(0.5) The project has a usable design layout, but may appear busy or boring.	2
Back-End Logic	(3) Background is exceptionally attractive, consistent, adds to the theme or purpose of the site, and does not detract from readability.	(2) Background is attractive, consistent, adds to the theme or purpose of the site, and does not detract from readability.	(1) Background is consistent and does not detract from readability.	3
Relevance	(1) All information provided by the student on the python project is relevant, Legal (if applicable) and all the requirements of the project have been met.	(0.5) Almost all the information provided by the student on the python project is accurate, legal (if applicable) and most of the requirements of the project have been met.	(0.25) Almost all of the information provided by the student on the python project is accurate, legal (if applicable) and few of the requirements of the project have been met.	1
Report	(2) Clear and Effective writing and adherence to appropriate style guidelines	(1.5) Writing that is clear and effective for the most part and minor errors in adherence to appropriate style guidelines	(1) Unclear and ineffective writing and multiple errors in adherence to appropriate style guidelines	2
Oral communication (presentation)	(1) Clear and effective communication	(0.5) communication is clear	(0.25) Unclear communication	1
Participation in Discussions	(1) Provided many good ideas; inspired others; clearly communicated ideas, needs, and feelings.	(0.5) Participated in discussions; on some occasions, made suggestions.	(0.25) Listened mainly; Rarely spoke up, and ideas were off the mark.	1
			Total	10

All the students' CIE marks distributions range between 31-50 marks which reflects the impact of active learning implemented in this course.

A. Impact of Active Learning for other courses

The students implemented the projects as part of the course in the fifth semester and the understanding of the programming constructs of Python was reflected in higher semester courses like Artificial Intelligence (AI), Data Science using R, Big Data, and Analytics. The Artificial Intelligence course is a comprehensive course in the curriculum of the sixth semester of Computer Science undergraduate

Sl.No	Question	M	CO	PO	BL
1.a.	Write a program that will calculate the average word length of a text stored in a file (i.e. the sum of all the lengths of the word tokens in the text, divided by the number of word tokens).	5	1	3	3
b.	"99 Bottles of Beer" is a traditional song in the United States and Canada. It is popular to sing on long trips, as it has a very repetitive format which is easy to memorize, and can take a long time to sing. The song's simple lyrics are as follows: "99 bottles of beer on the wall, 99 bottles of beer. Take one down, pass it around, 98 bottles of beer on the wall." The same verse is repeated, each time with one fewer bottle. The song is completed when the singer or singers reach zero. Develop a Python program capable of generating all the verses of the song.	8	1	3	3
c.	A pangram is a sentence that contains all the letters of the English alphabet at least once, for example: The quick brown fox jumps over the lazy dog. Write a function to check a sentence to see if it is a pangram or not.	7	1	3	3
2.a.	Design a procedure histogram () that takes a list of integers and prints a histogram to the screen. For example, histogram([4, 9, 7]) should print the following: **** ********* *******	7	1	3	3
b.	In cryptography, a Caesar cipher is a very simple encryption techniques in which each letter in the plain text is replaced by a letter some fixed number of positions down the alphabet. ROT-13 ("rotate by 13 places") is a widely used example of a Caesar cipher where the shift is 13. In Python, the key for ROT-13 may be represented by means of the following dictionary: key = {'a':'n', 'b':'o', 'c':'p', 'd':'q', 'e':'r', 'f':'s', 'g':'t', 'h':'u', 'i':'v', 'j':'w', 'k':'x', 'l':'y', 'm':'z', 'n':'a', 'o':'b', 'p':'c', 'q':'d', 'r':'e', 's':'f', 't':'g', 'u':'h', 'v':'i', 'w':'j', 'x':'k', 'y':'l', 'z':'m', 'A':'N', 'B':'O', 'C':'P', 'D':'Q', 'E':'R', 'F':'S', 'G':'T', 'H':'U', 'I':'V', 'J':'W', 'K':'X', 'L':'Y', 'M':'Z', 'N':'A', 'O':'B', 'P':'C', 'Q':'D', 'R':'E', 'S':'F', 'T':'G', 'U':'H', 'V':'I', 'W':'J', 'X':'K', 'Y':'L', 'Z':'M'} Implement an encoder/decoder of ROT-13. Once you're done, you will be able to read the following secret message: **Pnrfne pvcure? V zhpu cersre Pnrfne fnynq!**	8	1	3	6
c.	Consider the code given below, Analyze, identify the problem & correct the code print ("Your lone hero is surrounded by a massive army of trolls.") print ("Their decaying green bodies stretch out, melting.") print("His sword for the last fight of his life.") health = 10 trolls = 0 damage = 3 while health!=0: trolls += 1 health -= damage print("Your hero swings and defeats an evil troll,) print ("but takes", damage, "damage points.") print ("Your hero fought valiantly and defeated", trolls, "trolls.") print("But alas, your hero is no more.")	5	1	2	4

Fig 1: Sample Questions of CIE

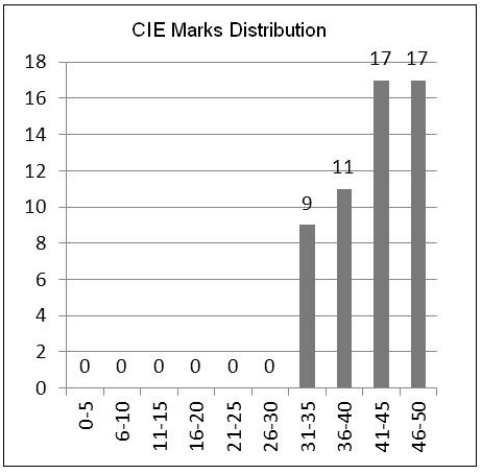


Fig 2: CIE Marks Distribution

program. The laboratory exercises of the AI course were designed in such a way that students can write the programs using Python. The utilization of the laboratory hours was to the full extent as students can start implementing these exercises without the extra effort in learning new language structure. In this course as part of the self-study, the students developed real life applications using techniques of Artificial Intelligence. These applications were implemented using Python. The students' strong background of programming constructs in Python in the earlier semester made them concentrate more on AI techniques than to concentrate on the programming syntax. Also, the active learning in Python enhanced the students' capability to use advanced constructs of Python Programming to support the development of AI applications.

6. Conclusion

In this paper, the design and assessment plans towards implementation of active learning for "Programming in Python" course for undergraduate students have been discussed. The methodology and activity plan of the course discussed above gave the students proper planning towards active learning and completion of their projects in time. The Evaluation rubrics helped the faculties to evaluate the student projects effectively and impartial. The impact of active learning helped the students to concentrate more on the project techniques and concepts rather than learning programming construct.

Acknowledgement

We would like to express our gratitude to B.M.S College of Engineering for providing the necessary facility required to implement Outcome Based Education. Also, we would like to thank our beloved Principal, Vice Principal, Dean Academic, HOD of CSE, our colleagues and all our industry partners for their constant support which helped us to implement the Outcome Based Education practices.

Reference

[1] Syed Akram, S. Selvakumar, J. J. Lohith, B. R. Shambhavi, M. Indiramma (2014) “Role of industry to improve outcome based education in engineering” in Journal of Engineering Education Transformations, Special Issue: Jan. 2015, ISSN 2394-1707.

[2] Hye-Jung Lee, and Cheolil Lim. “Peer Evaluation in Blended Team Project-based Learning: What Do Students Find Important?”. Journal of Educational Technology & Society 15.4 (2012): 214–224. ISSN 1436-4522 (online) and 1176-3647 (print).

[3] Tseng, Kuo-Hung, Chang, Chi-Cheng, Lou, Shi-Jer, Chen, Wen-Ping, “Attitudes towards science, technology, engineering and mathematics (STEM) in a project-based learning (PBL) environment”, International Journal of Technology and Design Education, Springer, February 2013, Volume 23, Issue 1, pp 87-102, DOI:10.1007/s10798-011-9160-x.

[4] Marilyn Rice, Li-Jen Shannon “ Developing Project Based Learning, Integrated Courses from Two Different Colleges at an Institution of Higher Education: An Overview of the Processes, Challenges, and Lessons Learned”, 2015 Proceedings of the EDSIG Conference, Wilmington, North Carolina USA.

[5] B. S. Bell and S. W. J. Kozlowski, “Active learning: Effects of core training design elements on self-regulatory processes, learning, and adaptability,” Journal of Applied Psychology, pp. 296–316, 2008.

[6] D. Bebell and L. M. O'Dwyer, “Educational outcomes and research from 1:1 computing settings,” Journal of Technology, Learning, and Assessment, 2010.

[7] R. Hasan, S. Ali and M. Hayat, 'Enhancing student's learning experience at middle east college by using blended learning', 015 Science and Information Conference (SAI), 2015.

[8] https://cei.umn.edu/support-services/tutorials/what-active-learning/elements-active-learning

[9] https://en.wikipedia.org/wiki/Project-based_learning

[10] https://www.wiksate.com/

[11] Forehand, Mary. "Bloom's taxonomy." Emerging perspectives on learning, teaching, and technology 41 (2010): 47.