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Statistical Analysis Software (SAS) Programming Course to Enhance Computing and Coding Skills of Biotechnology Graduates: A Case Study on Learner Centric Approach

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ABSTRACT The current paradigm shift in Indian higher education, particularly in engineering programs, is an ICT based education with mixed galore of pedagogical techniques. Employability of engineering graduates has been at stake for quite some time, and they directly attribute it to the curriculum design. In the current market scenario, having programming skills and computational knowledge for a biotechnology graduate is essential. This paper describes the implementation of a programming course on statistical analysis software for biotechnology engineering students as a study group. Pedagogical tools such as peer interaction and project-based learning approaches are used. In this study, it is observed that the students from non-circuit branches, such as biotechnology, learn programming courses with ease through a project-based learning approach when the project groups are structurally formulated. This paper highlights a mixed pedagogical approach and evaluates the impact through direct evaluation methods and feedback queries.

INTRODUCTION

As big data and data analytics are becoming mainstream, computational proficiency and literacy are essential skills for a graduate in the emerging multidisciplinary job market in India (Singh 2020). Using computing has revolutionised the field of biological sciences over the past years and almost all contemporary research domains such as biochemistry, molecular biology, clinical studies, agricultural sciences, and other biosciences use programming languages (Gibson and Mourad 2018; Tugizimana et al. 2020). The ability of programming languages to handle vast amounts of data with multiple parameters and processing redundant data in a short time makes it highly popular. The advances in computational technologies such as developments in hardware, software, algorithms, and cloud-based systems have increased the opportunities to introduce computing tools in these domains (Ekmekci et al. 2016). Industrial application of these computing tools or their use in the research field causes systematic training of computational skills. Baker (2017) believes that the graduating students of biology or similarly named programs with computational skills could be an excellent asset soon to industry and stresses that academic framework must address it. A concern that requires attention is the hesitance shown towards programming language courses by the students of biological sciences, especially in India. Considering the need for computing skills alongside domain specific training, the undergraduate curriculum in India may require a paradigm shift through implementing outcome-based education (Prasad and Jabeen 2020).

Programming languages vary in purpose and their usage. Each programming language and software package solves a particular problem, so one may not find the universal best programming language. There are several programming languages that are useful for biological sciences with different applications. One common application for almost every biologist is statistical analysis (Corsi et al. 2020). A statistical software that has more features and graphical annotations, and is easy to program and operate, with community support or web support becomes more popular (Carey and Papin 2018). Another major factor that is bundled with these factors is the cost. There are commercial packages, which offer rich resources to perform the required operations, and there are open source and free tools with limited resources. There are several statistical analysis packages available on the web, however, choosing one best may be difficult. Keeping academic and commercial use of the software in view, it is also necessary to identify a suitable set of such software and one most preferred to start with (Vicens and Bourne 2009). Software packages such as SPSS, Python, R, MATLAB, MS Excel or any spread sheet software, C/C++ and SAS are some of the programming languages that are commonly used in academics, research and life sciences industries (Masuadi et al. 2021).

The focus of this paper is to introduce statistical software, "Statistical Analysis Software" (SAS), to the undergraduate engineering students in biotechnology. SAS software is a command-driven proprietary statistical software suite widely used for statistical data analysis and visualisation. Compared to other statistical analysis tools, SAS software provides extensive support to transform and analyse data, along with a drag-and-drop interface. According to the official website of SAS, one hundred percent of Fortune 500 global life sciences companies use SAS software (Official Homepage of SAS 2021). Also, over 2,350 life sciences companies of all sizes spread over 45 countries, including India, use SAS software for its operations. The industries working in clinical research and data management are the largest users of this software in the life sciences domain. SAS has several packages, such as Base SAS, SAS/Graph, SAS/Stat, SAS/Enterprise Miner, SAS/Viya, SAS/AI and many more. Although SAS is commercial software bundled into different packages, it provides a free academic license for academic teaching and academic research known as SAS OnDemand Academics (abbreviated as SAS ODA). The SAS ODA license enables the user to make use of SAS Studio, Graph, Stat and Enterprise Miner for learning at no cost. However, the terms and conditions of this license forbids the use of this software for commercial use (SAS ODA Login Page 2021). The key features that make SAS a better choice to introduce it as a programming course in the undergraduate engineering curriculum of biotechnology are as follows (Wright et al. 2020; Homepage of SAS® University Edition 2021). It provides a free license for commercial SAS programming software used by life science industries and pharmaceutical industries. It is a powerful statistical tool that includes programming and a graphical user interface. Since it is a cloud-based software, installation is unnecessary. SAS software outputs are highly compatible with standards set by US-FDA electronic data submission formats. SAS Institute supports the curriculum development and availability of web-based resources, which makes it suitable software to incorporate in academics.

The successful implementation of a programming course for non-circuit branches, like biotechnology, should address two specific areas such as its commercial use (industry) and ease of use or programming (Lin et al. 2021). The ease of use referred to here is to make the course more learner centric and reduce the student hesitancy towards programming languages. This is possible by making use of a suitable mix of pedagogical techniques such as peer interaction, ICT, group learning and regular evaluation through objective type questions (Dikmen et al. 2017; Lokare et al. 2020). It will be easier for the student to go forward in learning it in depth once they are well acquainted with a programming language. It is also very important to fix the breadth and depth of the course to overcome the student hesitancy, which can be expanded at an advanced learning level. To be effective, the course curriculum must tap students' intrinsic motivations and address their core values (Duggal et al. 2021). Further, the availability of video tutorials, provision for interactive learning and collaborative learning positively influences the intrinsic motivation of a student. So, 'Helping Oneself and Others' (also called as H2O centred education), creates and sustains instructional environments where learners develop well-defined goals aligned with their intrinsic motivations and values, and also achieve the course objectives (Higley et al. 2020). In this direction, the H2O centred approach or a structured group learning method, is helpful in courses where students' psychological attitude and intrinsic motivations matter.

Objectives of the Study

The overall goal of this study is to perform a descriptive analysis on implementation of a programming based practical course on SAS software through a suitable mix of ICT and pedagogical techniques. Following are the research objectives defined for this study. To assess whether availability of self-learning materials and video tutorials enhance the intrinsic motivation in learning programming courses. To find whether randomised peer learning where a student takes help from their friend chosen by the student impacts learning outcomes. To make use of a structured group project work and assess its impact on learning outcomes. This paper describes method to form a structured group and project-based learning in line with H2O centred education for successful implementation of learning outcomes in programming courses.

MATERIAL AND METHODS

Details of the Software

A statistical software "Statistical Analysis Software" (abbreviated SAS) is used in this study. SAS is a commercial software bundled into different packages, and provides a free academic license for academic teaching and research known as SAS OnDemand Academics (abbreviated as SAS ODA). SAS ODA is available for non-commercial use to the students and teachers across the globe, free of cost. SAS ODA is a cloud-based software and operates through many of the major web browsers and on any of the operating systems. All web-based activities were performed on Google Chrome web browser (v90) in a Windows 10 operating system. The user needs to register and create a profile in the SAS ODA login or registration page (https://welcome.oda.sas.com/login). Users can register as faculty or a student. Faculty instructor and all the students used SAS ODA edition release v3.8 for all experiments. To access the SAS Studio and other packages, one needs to login to the SAS ODA using the link mentioned previously (Homepage of SAS® University Edition 2021). Android devices can also be used to access SAS Studio. A sample SAS Studio interface is shown in Figure 1. In the FAQ link of the login page, more details related to registration and login is available.

Details of the Curriculum

A programming course Biocomputing with SAS (abbreviated as BSAS) was designed and included in the curriculum of BE Biotechnology at NMAM Institute of Technology, Nitte and offered as a practical course in the academic year 2020-2021. The curriculum aimed at training the students on how to write SAS programs to access, explore, prepare, and analyse the data. This course was the entry point to learning SAS programming for clinical data management and fields related to data science. The course outcomes were set as follows.

CO1: Students should be able to make use of the SAS Studio to write and submit SAS programs that access SAS, Microsoft Excel, and text data.

CO2: Students should be able to explore and validate data, prepare data by sub-setting rows and computing new columns.

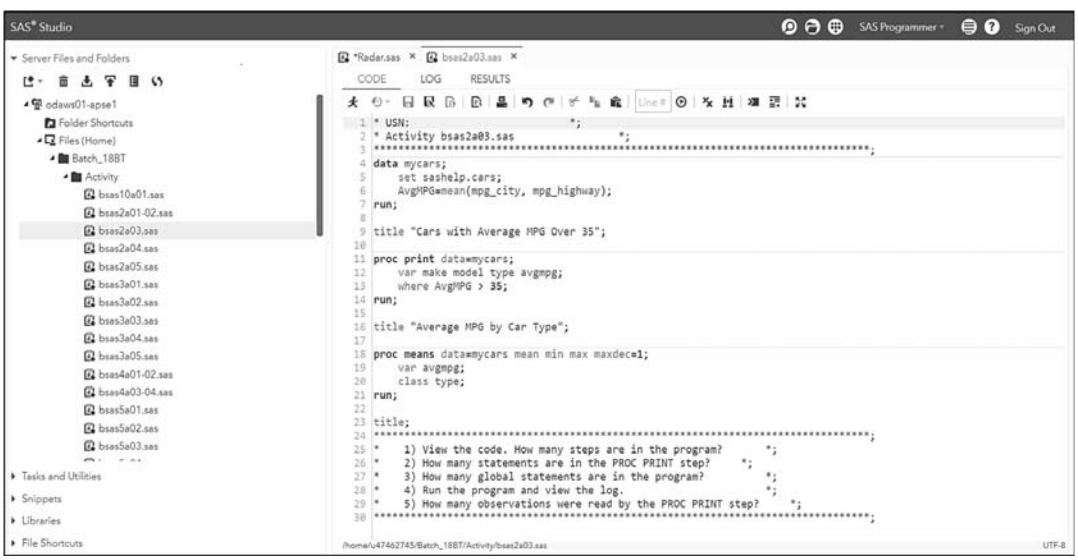

Fig. 1. User interface in SAS Studio
Source: Author

CO3: Students should be able to annotate the exploratory data, prepare output reports, and export data and results to a PDF or spread sheet as output.

CO4: Students should be able to use the descriptive and inferential statistical tools to analyse the data and report the summary results as PDF or spread sheet.

A 39-hour practical course was designed to meet the requirements of course outcomes. The practical components included registration to software module, login procedure, using SAS Studio for simple programs to complex hierarchy of data structure, graphical user interface (GUI) based data presentation and statistical tools. Table 1 illustrates the curriculum components and Bloom's Taxonomy level (BT) used for evaluation and mapped Course Outcome (CO) for each of the experimental modules.

Demographics of Study Group

This practical course with a blended mode of teaching and learning that includes group projects was conducted for a class strength of 67 that includes nineteen percent boys and eighty-one percent girls of age group 21-23 years. The CGPA range of the study group on a scale of 10 was as follows, that is, for 9 to 10, six percent of students, 8 to 9 was thirty percent, 7 to 8 was twenty-seven percent, 6 to 7 was twenty-five percent, and 5 to 6 was twelve percent. The CGPA was up to the previous semester and indicates a good mix of academic competence at the beginning of this course. Through the BE curriculum, all students have undergone a course on C programming in their first year of study. Also, most of them have used MS Excel previously for basic data collection work and plotting bar charts or linear plots.

Research Questions

To evaluate the research objectives, following questions were defined.

Question 1: Does the availability of self-learning materials and video tutorials enhance the intrinsic motivation in learning programming courses?

Question 2: Does randomised peer learning along with self-learning make any impact on learning outcomes?

Table 1: Curriculum of Biocomputing with SAS course and its mapping to Bloom's Taxonomy (BT) for cognitive levels and Course Outcomes (CO) used in this analysis. Bloom's taxonomy indicates the complexity and specificity of the course component

S. No.	*Components deliverable*	*Duration*	*BT*	*CO*
1.	Installation and data setup *(Registration, Login, Opening SAS Studio, File system, Components of Studio)*	1 hr	L3	1
2.	SAS essentials *(Use of SAS programming tools, components and the fundamental SAS program structure and syntax)*	2 hr	L2	1
3.	Accessing Data from SAS libraries *(Identification of the features of a SAS table, SAS libraries)*	2 hr	L3	1
4.	Importing data *(Data into SAS from excel spreadsheet)*	1 hr	L3	1
5.	Exploring and validating data *(SAS procedures, subset data, combine data, format data and sort data, identify and resolve duplicate data)*	4 hr	L4	2
6.	Preparing data *(data manipulations, filtering rows and columns, computing new columns)*	2 hr	L4	2
7.	Processing data *(conditional processing, iterative processing)*	6 hr	L4	2
8.	Analyzing and reporting on data *(summarizing data, use titles, column labels, footnotes, and use macro variables)*	3 hr	L4	3
9.	Exporting results *(export SAS tables and results to Excel, Microsoft Word, and PDF files)*	1 hr	L4	3
10.	Exploratory data analysis *(Creating various graphical output and reporting the output)*	4 hr	L3	3
11.	Statistical analysis of data *(Computing frequencies, summary statistics, one sample t test, two sample t test, correlation, linear regression, sample size and power of test)*	6 hr	L3	4
12.	Plotting survival analysis curve *(using inbuilt GUI based plotting tools)*	1 hr	L3	4
13.	Minor project work *(Discussions and Evaluation)*	6 hr	L5	1-4

Question 3: Can a structured group project work produce higher impact on learning outcomes than randomised peer learning?

These questions were assessed through direct evaluation methods and student feedback.

Methodology of Course Implementation

The course on Biocomputing with SAS was introduced as a practical course to the students of BE Biotechnology at NMAM Institute of Technology, Nitte during the academic year 2019-2020 for the first time. Improvised curriculum that includes project work as shown in Table 1, offered to the sixth semester BE Biotechnology students in the academic year 2020-2021, is the focus of this case study. The course instructor has undergone training in SAS programming offered by the SAS Institute and a certified professional SAS programmer. This course was administered using blended modes of teaching and learning approaches. These approaches include providing self-learning mate-

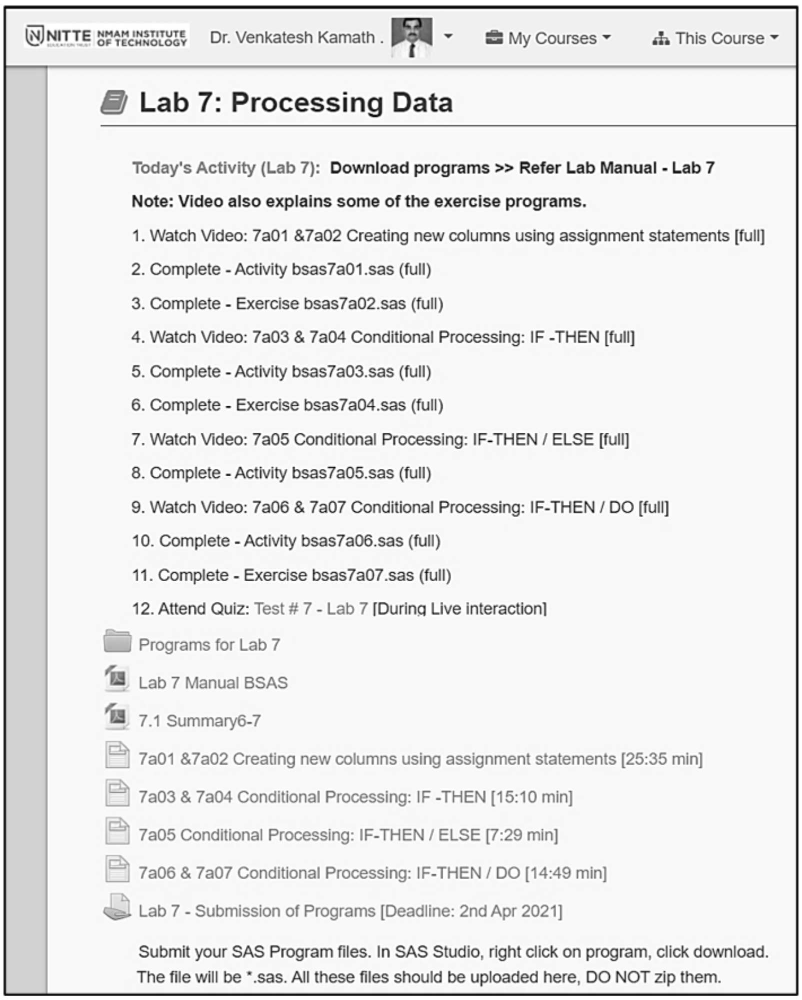

Fig. 2. A sample of course administration through Moodle. A tab for Lab # 7 consists of step wise instruction to learner, reading materials, program files, video tutorials and weekly quiz. Similar tabs are made available for all labs and for project and additional resources
Source: Author

rial, video tutorials, and group project. All the activities were controlled through the Moodle 3.1 server (hosted on the Institute server) accessible via intranet and Internet. A sample of activity page for Lab # 7 is shown in Figure 2. Alternatively, Google Classroom may be used for course content delivery. The pedagogical approaches used include instructions for self-learning, unstructured peer learning and structured group project. These methods are described in the following paragraphs.

The reading materials to learn the code description and components of software were provided through the Moodle learning management system. Program files for execution were provided as three tiers for each set of codes. The first-tier program file was completely pre-written, and the student had to just execute the same. This enables the student to understand what each part of the code performs. The second-tier program was a partially written code, which students need to complete and then execute. This second program enables the student to use the concept learnt from the first program 1 and extend the same. The third-tier program was just a question describing the output required. In this third case, the student needs to write a complete code and execute the program. Different data sets required to execute these programs were given to the students. The datasets available in SASHELP library within the SAS Studio were also used.

Video tutorials, prepared by the author were provided through the Moodle course page (YouTube link to these videos: https://youtube.com/playlist?list=PLrqvoPRYv-C3ov2nr6mylSO_AKU0VRECD). Some videos available in SAS Resources webpage were used for Statistical Analysis and Survival Analysis. These tutorials should help the students to understand the tier-1 programs as described previously. In these video lectures, key components such as cognitive load, elements to promote active learning and elements that impact engagement were incorporated (Brame 2016). Course instructor support, along with peer learning approach, was provided to complete tier-2 and tier-3 programs. Care was taken to ensure that individual students take part more actively in program execution through guided tutorial video rather than classical technique of face-to-face explanations and guidance for every batch of students. This ensured not only uniformity in explanatory guidance to students but also ensured high level monitoring of student activity and engagement in problem solving. Based on the activity of each module weekly quizzes were conducted to assess direct attainment.

Based on the cumulative scores obtained by the students in weekly quizzes, four quartiles of students were created. These quartiles refer to Q1 (top 25%) as fast learners, Q2 (upper middle 25%) as above average learners, Q3 (lower middle 25%) as below average learners and Q4 (bottom 25%) as slow learners. The project group was composed of one student each from each of these four quartiles. Students were given freedom to make their own groups adhering to this composition rule. The students belonging to Q1 category were made the team leaders. A project work on faculty demographics with an objective to prepare automated reports in the form of tables and graphical analysis was given. The project task resembles the demographics task used in clinical research data management industry. The datasheet to work on and a reference problem statement was provided to the teams. Each team had to come up with problem statement that included data description, statistical analysis plan (SAP) or analytics requirements and mock shells as per the clinical data management industry terminology. Teams were permitted to modify or include new datasets as per requirement. This exercise helps in understanding real world problems where SAP and Mock Shells are defined by the authorities and teams need to work on it. This activity hypothesises the enhancement of skills like teamwork, knowing the depth of a problem statement and realities, understanding the use of codes in a better way, learn to use SAS documentation and SAS communities for help, reviewing of codes and comments, by making use of codes that were not taught in the curriculum (beyond the curriculum). Support and suggestions were given by the faculty instructor at every stage of project execution. Student teams had to present their project work and make necessary changes as required before final submission.

RESULTS

Direct Evaluation of Course Outcomes

The direct evaluation of course outcome attainment was mainly made through weekly quizzes and group projects. The weekly quizzes conducted soon after the face-to-face interaction are highly useful tool, as this can adapt corrective measures to the same set of students immediately. Although scores obtained through mid-semester and end-semester exams are used for course outcome attainment analysis, these evaluation scores are useful for improvement of next upcoming batches (Ramchandra et al. 2014). These scores are not very useful to cater to the immediate needs. Hence, only scores attained through weekly quizzes and projects were given priority in this case.

Assessment through Weekend Quizzes

The percentage attainment of each course outcome through weekend quizzes and project work are shown in Table 2. The percentage attainment is measured as percentage of learners who scored more than or equal to sixty percent of maximum marks allotted to each test item (Premalatha 2019). The graphs presented in this paper are plotted using SAS Studio.

Table 2: Percentage attainment of course outcomes through test items weekly quiz and group project work. The attainment is compared with compliance level of 60 percent. Improvement is observed for CO3 after adapting peer learning activity through group project is introduced

Course outcome	*Percent attainment through module wise quizzes*	*Percent attainment through group project evaluation*
CO1	81	90
CO2	73	87
CO3	54	90
CO4	77	85

An attainment of more than sixty percent for each course outcome is compliant as per the Institute wide norms at NMAM Institute of Technology. Accordingly, attainment of CO3, or 'annotating the exploratory data, preparation of output report, and exporting data and results to PDF or spread sheet format' has not met the compliance requirements. A special online interaction session via Google Meet was held to clarify the misconceptions amongst the students. Impact of this interaction session and the compounded effect of peer learning though project work was evident through an improved CO3 attainment in the project work, evaluated at a later stage.

Assessment through Project Evaluation

The assessment of the project was performed through a group presentation of their work where questions specific to their work were asked to each student and evaluated accordingly. The questions were focused on to know whether the learner understood the usage and its impact on the output. The peer learning through a group project seems to have worked well to achieve the main objective in offering this course. A paired t-test was run on percentage attainment of four COs obtained through the weekend quizzes and project work to determine whether there was a statistically significant mean difference between the attainment obtained in two evaluations methods. This statistical analysis was conducted using SAS Studio GUI. A marginally significant increase in mean attainment by 16.75 percent (at 5% significance level, $t(3)= 2.56$, $p=0.0834$) through project work is observed. This indicates a successful implementation of the group project-based learning method adapted as described earlier.

Descriptive Analysis of the Feedback and Self-evaluation by the Learner

A detailed questionnaire was prepared to receive self-evaluation feedback from all the students. The data was collected through the Moodle interface where the course contents were administered earlier. Anonymity of the student was maintained to provide a fair chance to respond with genuine answers. Among the 67 registered students, 64 students responded to the query within the time frame and the same is used for this analysis. This analysis has more impact on this case study than direct assessment, as it objectively testifies the teaching and learning method, learner expectations, reach of course deliverables and hidden problems that are associated with learner. Hence, the feedback was divided into multiple sections to assess the student expectation and competence retrospectively and teaching and learning approaches used prospectively. A dissection of this feedback analysis is discussed here.

Infrastructure Availability

For conducting face-to-face practical sessions, enough computer facility was available at the Institute. However, to learn the programming course it is always advisable to have a personal computer or desktop with an Internet connection. Through responses, the researchers learn that ninety-one percent of the students possessed a laptop with Internet connection, five percent of students purchased a new one whereas remaining four percent of students took the help of their friends' laptop.

Student Perception on Computational Skills

All the students have already gone through a programming course in their first year of study. As a non-circuit branch student, generally biotechnology students dislike programming courses. Hence, a set of queries in this context and their response is listed in Table 3. About thirty-four percent of students had no issues with programming courses and another thirty-nine percent said they can 'manage to pass' with programming courses. However, twenty-seven percent responded with having great difficulty in programming related courses. Since they have used MS Excel and SAS Programming with tasks like that of a spread sheet, responses were obtained about their knowledge in MS Excel. About sixty-eight percent of students could do basic activity using MS Excel. This course was offered as a core course and all students had to register. So, a query on this regard showed that at least fifty-one percent of students had an interest in programming course while registering. One third of the group considered this as an opportunity to build their resume for career enhancement. One third of the class group had already undergone programming courses in their internship such as Python programming. All those students who showed high interest in programming courses (Q1.1 in Table 3) have undergone coding or programming courses in their internship. Through these queries and cross-sectional analysis, it appears that two-third of the class may require pedagogical tools to enhance their interest in this programming course. Hence, a blended mode of teaching and learning that involve techniques as mentioned earlier in course implementation section were adapted.

Role of Quality Learning Materials and Self-guided Tutorials

The researchers made specific queries to assess the quality of learning resources provided,

Table 3: A retrospective feedback response by the study group regarding a programming course. This feedback report is collected through Moodle Feedback tool

Feedback question	*Number of responses*	*Percentage of response*
Q1.1 Before registering into this course, your interest in courses with coding or programming		
It was always interesting to me	9	14.1
I had no issues with programming courses	13	20.3
I could manage those courses to some extent	25	39.1
I struggled to manage the course	13	20.3
It was never interesting to me	4	6.2
Q1.2 Your knowledge level in using MS Excel or any spreadsheet software		
I have deep knowledge in using MS Excel	1	1.6
I can do plotting, calculation, and stat analysis in MS Excel	13	20.3
I can do plotting and calculation in MS Excel	30	46.9
I can plot the graphs in MS Excel	17	26.5
I do not know properly to use MS Excel	3	4.7
Q1.3 Perception about this course (before registering)		
I am curious to learn a new programming language	16	25.0
I like to explore a new domain / a new course	17	26.5
I wanted to know whether it is helpful for my carrier	22	34.4
It is just another core course, so I registered	9	14.1
I was never interested in this course	0	0.00
Q1.4 Have you undergone any coding or programming courses before this (beyond syllabus)?		
Yes	23	35.9
No	41	64.1

video tutorial and teaching methods. About ninety-eight percent opined that course material provided was adequate and contained all necessary information required to understand the concepts. It is also to be noted that the web links to learn beyond the information provided in the course material were also provided. Interested students would go through it, if necessary. About five percent of students responded that there is a requirement to re-organise course content to some extent. However, ninety-five percent of students believed the manual was well structured and organised as per course deliverables. The same students also believed that the video tutorial provided for self-learning was informative, crisp, and clear to perform programming exercise. Benitez (2020) showed that developing quality learning material is highly useful to overcome students' learning difficulties, and it strengthens their technical competency.

Role of Unstructured Peer Instruction to Complete Course Deliverables

To assess whether students could complete the programming activities given each week on their own or required additional assistance, programming activities were delivered through 3-tier processes as described in the course implementation section earlier. The responses to these queries are shown in Table 4. About forty-eight percent of students could perform the programming activities on their own by watching video tutorials. However, fifty-two percent took help from their friends showing a strong peer interaction activity functioning in the background. Also, when asked to choose one of the best options for teaching and learning method (Q2.2 in Table 4), seventy-eight percent of the students chose peer interaction given all the learning resources. Besides, sixteen percent of students felt live face-to-face interactions with the instructor was also necessary to complete their activities. A cross-sectional analysis of these responses with retrospective queries showed that students who required live interaction either responded as not interested in programming courses or not undergone any additional programming courses or struggled to manage programming courses. Evidently, from direct evaluation though weekend quizzes there were at least about twenty percent of students who could not score more than sixty percent of the score. Since the feedback analysis was carried out anonymously, cross-sectional evaluation is not available in this case. As an anticipatory action, instructors conducted one-hour live sessions each week to clarify the misconceptions. All students rated this anticipatory action either as an excellent or very good approach. Hence, it is suggested to make use of very good learning resources along with video tutorials and make provision for peer learning for better understanding. As a measure to provide additional inputs to slow learners, one must conduct interaction sessions and focus upon the problems faced by these slow learners by involving them actively during these sessions. To assess the effectiveness of these approaches there should be regular evaluation. The quizzes conducted each week in this course were termed as 'Knowledge Quiz', as the objective type questions not only assesses the student perception but also provides deeper understanding of the topic. The quizzes were kind of open book exams where students could refer to their course material but not seek help from others. Questions were designed to think in line with programming activities performed. The feedback response from students on the knowledge quiz indicated that the misconceptions were cleared to a major extent. About ninety-five percent of the students believed that misconceptions were cleared and ninety percent opined it as a good approach to have quizzes each week.

Role of Structured Approach in Peer Interaction through Project Based Learning

Though the peer interaction is a successful tool in this course, it required a structured approach to achieve the main objective of understanding the programming structure and converting the codes learnt into an application. So, a group project activity was given to the study group. Based on the knowledge quiz scores the class was divided into four sections as explained earlier in course implementation section for project work. The groups to execute project work constituted a fast learner, a moderate learner, an average learner, and a slow learner. The peer learning in this approach ensures that group members working together would learn in a better way. There were 16 groups with a fast learner as its team leader. Among 16 team leaders, 10 students did not take up any programming course other than C programming earli-

Table 4: Response recorded in Moodle feedback report for queries related to self-learning, peer interaction and combinations to execute weekly programming activities

Feedback question	*Number of responses*	*Percentage of response*
Q2.1 Video Tutorial: Whether you can learn the programming yourself by watching tutorial video and practicing on your own?		
Definitely yes	31	48.44
Yes, but required additional help from friends	29	45.31
Yes, but required additional help from instructor	3	4.69
No, I required more instruction (friends / instructor) further to understand programming	1	1.56
Definitely No, this video tutorial is not at all helpful in learning	0	0.00
Q2.2 Teaching - Learning Method: Choose one best combination you prefer		
Self or independent learning without peer interaction, given course material and Video tutorial as resources	4	6.25
Self-learning along with peer (classmate) interaction, given course material and Video Tutorials as learning resources	50	78.13
Live interaction (no lecture) along with course material and video tutorial provided as resources	0	0.00
Live short lectures besides providing course material and video tutorial as resources	6	9.38
Detailed live lectures and interaction besides providing course material and video tutorial as resources	4	6.25

er. All the team leaders responded as "like to explore" or "curious to learn" in a retrospective feedback question related to perception of this course before registering (Q1.3 in Table 3). So, the team leaders were self-motivated and seemed to be perfect choices. The project work constituted of writing codes to generate a required output. Teams had enough flexibility to change the problem statement so that they understand the importance of codes and their usage. The teams were constantly in touch online and executed the codes and submitted. The project was evaluated through a rubric that included weighted scores for all steps starting from a problem statement through coding to presentation and resubmission of the corrected report. The feedback response on project work was analysed (Table 5). About ninety-five percent of students believed that the project work activity helped in understanding the application of programming skills and the remaining five percent were not sure of the same. Project work also helped them to learn beyond the curriculum, as responded by eighty-one percent of students and another fourteen percent were not sure of the same. In terms of enhancing their programming skills, ninety-five percent of students agreed that project work helped them but nearly half of them were not very confident yet. This is in good agreement with direct evaluation of project work as described earlier. They have understood the importance of data analytics by the end of this project activity. This possibly achieves the basic objective of the course wherein students need to understand the application of their acquired skills.

Skill Improvement

Students' response was taken after completion of the project activity and programming course to assess how this course has changed their overall perspective. The response to these queries is given in Table 6. Through project work following skills were also improved, that is, communication skills (90% of students), teamwork (92%) and convincing abilities (63%). About eighty-five percent of students are now confident enough to use programming skills, which was fifty-two percent before commencement of this course. Nearly eighty-five percent of students rated this course as above average or excellent and another fifteen percent rated it as well. This shift of student attitude towards the programming course indicates positive inclination if the course is offered through a well-designed self-learning course material and delivery through structured teaching-learning processes.

Some of the students gave descriptive feedback in the form of testimonials or comments. Almost every feedback turned out to be positive in nature. The key common points, with no particular order, were, "gained good learning experience",

Table 5: Response report from Moodle to feedback queries related to effectiveness of group project work on deeper learning of SAS programming

Feedback question	*Number of responses*	*Percentage of response*
Q3.1 Minor Project: Whether minor project helped you to apply the programming skills you gained in this course?		
Yes	61	95.31
No	0	0.00
Not sure	3	4.69
Q3.2 Whether minor project helped you to learn beyond what you learnt in this course?		
Yes	52	81.25
No	3	4.69
Not sure	9	14.06
Q3.3 Whether the teamwork was very useful to explore more coding options and enhance your skills?		
Definitely yes, the teamwork has improved coding skills significantly and increased the confidence	34	53.13
Yes, to some extent coding skills are improved but not confidently	27	42.19
Not greatly, skills gained during practical course are just strengthened, learnt nothing new	2	3.13
It neither improved my coding skills I had before this project nor decreased (Nothing changed for me)	1	1.56
It has made me more confused in programming	0	0.00
Q3.4 As a team leader or member, your observation about team activity		
Team involved in this activity, and all were equally providing input and working coherently	53	82.81
Team involved in this activity, and I was giving more input to the team	9	14.06
Team activity was average and did not work greatly as per my expectation	1	1.56
Team lagged in all assigned roles, and I had to motivate the team to complete assigned tasks and somehow, I got it done	0	0.00
Team was not much active, and I had to complete the works on behalf of my team. However, they helped me here and there	1	1.56

Table 6: Response report from moodle to feedback queries up on completion of project activity and programming course

Feedback question	*Number of responses*	*Percentage of response*
Q4.1 Whether project activity increased your communication skill, teamwork, and ability to convince others?		
Increased communication skill, teamwork, and ability to convince others	35	54.69
Increased communication skill and teamwork	23	35.94
Increased communication skill, and ability to convince others	3	4.69
Increased teamwork and ability to convince others	2	3.13
Did not increase these skills	1	1.56
Q4.2 Are you confident enough to participate in SAS coding activities now and use skills gained for professional use?		
Strongly agree	13	20.31
Yes, to some extent	41	64.06
Not sure	10	15.63
Q4.3 How do you rate this course among other programming or related courses you have learnt?		
Excellent	23	35.94
Very good or above average	31	48.44
Good or average	10	15.63
Poor or below average	0	0.00
Very poor	0	0.00

"project work helped a lot to understand", "learnt coding", "very interesting", "improved technical skills", "very useful course for data analytics in biotechnology", "we are definitely using it in the future" and many more. These testimonials reflect upon the successful implementation of SAS programming course through H2O centred education where student psychology in learning through peer interaction matters. Best-chosen testimonials given by the students are given here in the words of the learners.

"*I liked SAS programming very much. The coding involved here looks complex, but it is not so when we try to understand the reason behind every term used there. If I were to suggest someone on which coding language to start with, then I would recommend SAS, as it involves the basics of every software coding language. Also, it has a great career-based perspective. Online Certification of SAS is of great help.*"

"*It was totally a new experience to work with the team. Though the online interaction made the work harder, we learnt many things. Being a leader, I definitely want to tell, teamwork taught me a lot. About the course it was interesting and very helpful. Loved working with SAS.*"

"*To be honest, BSAS is the course I enjoyed and was interested the most in this semester. It was really nice to learn something new and this course gave us so much confidence. Personally, I am more interested in coding after this course. It gave us an opportunity to do teamwork and this minor project bridged the gap between students during the pandemic. Though it was stressful, we got to explore so many things in SAS. It also seems like the 'coding is difficult' taboo has reduced so much in students. I am interested to learn further about SAS.*"

DISCUSSION

Practical course in SAS Programming involved the use of blended modes of teaching-learning approaches such as self-learning materials, video tutorials, and group project. The self-learning materials were provided in the form of program codes, reading material and video tutorial. The direct evaluation of self-learning through weekly knowledge quiz is satisfactory except for course outcome 3. Compared to the student perception evaluated before and after the course, it shows that the student involvement increased when sufficient interactive self-study materials are provided. The instructional materials boost the intrinsic motivation towards self-learning when the video tutorial is crisp and includes contents that involve a thinking process and sufficient web based support (Carey and Papin 2018; Garrett 2021). Students, when provided with additional resources from web, as in this current study, engage to learn beyond the syllabus. This increases the student participation in the course (Vicens and Bourne 2009). Another factor that motivated the students to be involved could be that the course is directly affiliated to industry requirement that led to the increased placement opportunity (Lin et al. 2021). Due to digitalisation of the traditional classroom environment, most students in higher education institutes have acclimatised themselves to the post COVID-19 state of education. However, family financial conditions should not be overlooked while considering the basic requirement of personal laptops to pursue this course (Ashri et al. 2020).

Inclusion of peer-learning facility alongside self-learning enhances the student participation in the course. In the current study, student engagement as observed though direct evaluation and feedback analysis has made significant impact on learning outcomes. However, here peer learning is a random choice of the learner and not controlled by the instructor. This could lead to different possibilities such as a weak student trying to learn along with another weak student since they are good friends (Lokare et al. 2020; Lin et al. 2021). The feedback analysis on randomised peer learning showed the students' learning ability to increase through the peer learning process alongside video tutorials (Brame 2016). This is a good indication to implement a structured approach to formulate student groups. H2O centred education nurtures intrinsic interests of the learner and their self-exploration by creating an authentic, open learning environment for better understanding (Higley et al. 2020). To facilitate this, a group project activity was executed through a structured approach in this study. O'Hara and Montreuil (2019) recommended that a structured approach to implement small group learning activity by involving high-achieving students (fast learners) yields better performance. Further, authors recommended the teachers to ensure that each student is provided a specific role and set expectations for each student as well as the team. So, in the present case, a fast learner was made the team leader and specific set of roles were given, which the team leader had to assign it to the team members (Dikmen et al. 2017). The group was formulated based on their scores obtained in weekly quizzes. This ensured a uniform group comprising one student each from four quartiles that represent learning ability of the students. The assignment of roles and their performance was evaluated through project presentation. The direct evaluation of the project as well as feedback analysis was coherent and indicative of successful implementation of the structured group learning approach. The student testimonials suggest that active learning in this course has paved way for critical thinking among them and increased their enthusiasm towards coding. This study on implementing a programming course for the biotechnology program suggests the use of a structured group learning approach to increase student participation and meet the course objectives. Some of the programming courses may be available as MOOCs in Coursera, Swayam and NPTEL (Prasad and Jabeen 2020). However, only self-motivated students end up taking these programming courses. Slow to regular learners require additional support for learning, and hence they do not appreciate to register in these courses (Duggal et al. 2021). In such cases, it is recommended to have a blended mode course offering where students should be encouraged to take up MOOCs and provided with additional support from the department faculty.

CONCLUSION

The common fear among biotechnology students regarding a programming language or software is not because it is difficult to learn, but instead, because it depends on how they learn it. Structured methods of peer learning are among the best pedagogical tools, when used as a learner centric approach in any course to achieve the overall objective of academic learning. The complexity of the learning path is best known to the first-time learner than the experienced instructor. In this case study on implementing a new practical course on SAS Programming, peer learning in combination with a structured group project seems to be a useful tool in achieving the main objective of this course. It is beneficial to offer one or two programming courses in biotechnology curriculum to improve logical reasoning skills and use of digital technologies in the field. Having trained with these skills, a graduate's potential to be employable increases.

RECOMMENDATIONS

The direct evaluation through tests and projects, retrospective and prospective feedback analysis and the course instructor's observations are used to arrive at the following recommendations. SAS Programming is one of the important programming tools used for data analytics and case report form preparation by most of the pharmaceutical and life science companies. Having good programming skills in SAS software could prove beneficial to a graduate's career. Inclusion not only increases employability of the graduate but also increases aptitude and logical reasoning skills of the graduate. The course needs to be offered as a practical course with adequate resources in the form of reading materials and video tutorials. SAS Institute provides several such materials for academic purpose and should be made best of it. Assessment of concepts learnt through programming should be regularly conducted and corrective measures should be immediately taken, as necessary. Programming courses are best learnt through project activity clubbed with peer learning. The formation of groups plays a vital role. It is recommended to formulate groups using a structured approach like one described in this paper. There should be constant interaction between the instructor and teams while working on the project. Students may end up with technical difficulties and may not get a solution on the web. The instructors' intervention and timely advice not only help the project's progress but also increases the confidence of students. The project given should be flexible enough and not too complicated. Teams should be given a free hand in improvising the problem statement. With this freedom, the team's reasoning, logical and programming skills get enhanced.

LIMITATIONS AND SCOPE OF THE STUDY

This case study was conducted for one batch of BE Biotechnology students within the Institute. Nevertheless, for the curriculum and methods of admission to BE Biotechnology or similarly named courses, most of the students in this study group have already been exposed to the use of computers and MS excel. For the case with a student group, which is not much exposed to computer could be quite different. However, given the current situation of the COVID- 19 pandemic and revolution in digital mode of teaching for distance education, this should not be a hurdle soon. SAS Programming course may be offered at the early stage of engineering programs like during the first year or second year of study. However, here in this case it was offered to third-year students with an intention to help placement opportunities in their final year.

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