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Project-based Iterative Teaching Model for Introductory Programming Course

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Abstract

Introductory programming courses are considered to be the most important courses taught to undergraduate computer science students. However, teaching these courses in the best way possible has always been difficult. Mostly, students are unable to form the relation between the theory and the practical work. Thus, they find it difficult to put their skills to use, when they are required. This has been a centre of discussion among educational researchers for quite a long time. Many approaches have been brought forward and out of these; Project-based Learning is on top. PBL has been introduced in combination with various other frameworks to teach programming i.e., agile, scrum and task-driven teaching. Although, none of these approaches provides the teaching content for developing the project iteratively. In this research, we have merged Project-based Learning with an iterative approach to build-up a teaching model that will help students learn the skills and implement them accordingly with the help of a project. Students learn one skill at a time and implement that in the project. We also present our experience with the course taught according to this approach to undergraduate computer science students of session 2020 at the University of Engineering and Technology, Lahore, Pakistan. Results show that the iterative teaching model proposed in this paper addresses various shortfalls of the previously presented techniques and fulfils the requirements of an introductory programming course. Furthermore, the results also show an increase in the motivation of the students towards learning programming.

Keywords: introductory programming course, project-based learning, iterative project-based learning, teaching model, computer science

1. Introduction

From classical computers to quantum computers (Mermin, 2007), the journey on the road of technological advancement continues. Programming (Gries, 2012) is the core of this revolution. Due to this, the trend of becoming programmers has increased in the students (Adeoti, 2019). Although, the majority of the students perceive different programming languages as hard to learn (Vega et al., 2013). This is due to the fact that most educational institutions follow the Knowledge Based-Learning (KBL) approach (Whitehall & Lu, 1994). In the KBL approach, students are given excessive information, even the information that is not needed at the moment. The students learn from the lectures fixed at the pace the professor has decided. Furthermore, there is incoherence between the concepts taught in the theory and the project in the lab (Raval, 2019). Therefore, KBL has not proved to be effective for developing the problem-solving skills in students.

Besides efficiently transmitting information in the theory session, the teacher should also focus on developing an association between the theory and practice (Fioravanti et al., 2018). Balancing the theory and practice is a recurring challenge to teach programming languages and has been the centre of debate among various educational researchers. To find the balance between theory and practice, many methodologies have been introduced e.g., project import (Guang-yong, 2011), ACM competition platform (HeYingsheng, 2009), task-driven teaching (Liu et al., 2018). These approaches make students to write various programs which aim at certain teaching objectives, but these practises are not designed according to the students' future professional position in the real world (Ge & Ding, 2012).

In order to become a successful programmer, a student must know how the logistics of programming works, how to debug it, and mainly how to develop the skills along with the syntax and semantics (Jazayeri, 2015). Thus, the basic challenge for the instructor of programming is to know how to direct the learners and how to prepare them for professional life to achieve the targeted goals of software companies (Amamoua & Cheniti-Belcadhi, 2018).

To fulfil these needs, educational researchers have proposed a student-centred pedagogical approach called Project-based Learning (PBL) (Souza et al., 2019). PBL directs the focus on the motivation of students and their skills development at the application level. Student-centred approaches develop higher motivation in the learner as they learn by doing. Hence, better learning on the development level (Prikladnicki et al., 2009). PBL aims towards the motivation of students by providing them with a vision. The students steadily approach their goals while gaining knowledge and developing relative skills. This raises motivation and makes the learning process pleasurable for students as they proceed towards their goal. When students find the learning process aligned with their interests, they develop a sense of pleasure and motivation. The brain of these students releases a neurotransmitter called dopamine which boosts motivation in students and provokes them to learn new concepts (Krauss & Boss, 2013). PBL approach is accepted widely due to its connection between theoretical knowledge and its practical application (Todorova et al., 2010).

The main purpose of this approach is to make students work-ready as it is a pedagogical approach to prepare students for professional life after university (Olayinka & Stannett, 2020). In the last two decades, the PBL approach has been generally acknowledged due to its pattern of distribution over several iterative deliverables and feedback queues, which encourage the students towards quicker development (Siegeris et al., 2018).

For further addition to the advantages of PBL, there have been several valuable studies about the methods and techniques used for teaching different courses using PBL with the agile approach e.g., the contents of the courses are modelled in a weekly manner (Giese et al., 2020) which develops a roadmap to be implemented in a duration of a week. On the other hand, some models emphasize learning through a series of cycles such as the scaffolding technique (Bygstad et al., 2009), in which a student is provided with the necessary support to moderately master the skill which is needed to complete a task. In (Sakulvirikitkul et al., 2019), the concept of Agile Scrum software development is presented which focuses on the development of a learning process as per the Scrum Framework to be followed by students and acquire various programming skills along the way.

Although many studies are using PBL with the agile approach to develop the project, but the project is offered at the end of the semester which makes it unfit, because students are unable to form a connection between the learned concepts and the project and they have to use all the previously learned programming concepts. Moreover, none of these studies provides the teaching contents (theoretical programming concepts) in an iterative manner for developing the project. As, it is tough for the teacher to map the project tasks with the contents delivered via lectures and develop them incrementally because the project task needs to be prepared in a way, they do not require the knowledge or skill that students have not learned yet. Thus, the present agile-based PBL lacks the design of the iterative learning path towards project development. Due to this, most of the students fail to deliver a fully functional project at the end of their semester.

Thus, the goal of this research is to propose an iterative teaching model for programming content and fully mapped projects with those contents to help the learners in expanding their programming skills and striving in professional life. In simple words, the aim is to use the iterative method of content delivery with project development throughout the entire course. This will increase the motivation of the students. It will allow the students to learn a skill from the lectures delivered in the classroom and then apply that skill directly to the project in the form of solving a subproblem or developing a sub-feature of the project. In the end, the students will be able to develop the whole project incrementally by learning and implementing it step by step. In particular, a student will learn a skill through theoretical lectures and then practically implement it to develop a part of the project during the lab sessions.

This paper focuses on answering these two research questions: What possible phases need to be part of iterative PBL? What effect does the proposed PBL have on the extrinsic and intrinsic motivation of students?

Rest of the paper is structured as follows: Section 2 provides a detailed literature review on the teaching methodologies and presents a research matrix to summarise the survey. In section 3, we discuss our proposed iterative project-based learning methodology for teaching the introductory programming course. Section 4 describes the experimental framework used to evaluate our proposed teaching model. Section 5 and 6 gives the results obtained and then discusses those results respectively. Section 7 concludes our paper.

2. Related Work

Various methodologies have been proposed and presented in the past to engage students in the learning process. In the beginning, a pedagogical approach Knowledge-Based Learning (KBL) (Whitehall & Lu, 1994) was introduced in which certain educational objectives needed to be fulfilled using various tools and technologies.

Mann, S. et. al. (Haden & Mann, 2003) introduced a two-semester introductory programming sequence to form a relation between traditional procedural programming and advanced Object-Oriented system development. The approach was to deliver the new material in each lesson that builds as much as possible on that learned in earlier lessons. The authors observed their students and classify the errors they made in the set of 36 types of errors. The outcome or shortfall observed by assessing the learners was that the students learned to use the complex components but they didn’t develop an understanding of the task performed. In 2005, a tool named Phoenix (Flood & Lockhart, 2005) was introduced to make the students collaborate with the teachers on the conceptual development of the programming language they used. In that way, the students came up with the essential ideas and became familiar and confident about the task to be performed in that programming language. A survey was conducted and the students responded positively in the favour of Phoenix. The approach was not evaluated for the performance of students and was under development for exploration over the internet.

Robins, A. et. al. (Robins et al., 2003) considered a widely used approach for teaching various programming languages to novice learners and gave the respective results while depicting various shortcomings. Under this approach a course was designed based on lectures and practical laboratory work, the focus was shifted to the knowledge basis besides a conventional curriculum i.e., the taught components of the language and their usage. The author identified several trends that summarise that this method of teaching doesn't provide the learners with sufficient knowledge and the learners are not provided with satisfactory instruction.

T.B. Bati et. al. (Bati et al., 2014) proposed an approach to redesign a course to teaching and learning of programming by using constructive alignment and Bloom's taxonomy. The assessment activities were designed with a focus on students' formative assessment i.e., assignments, projects and journals. Additional assessments included alignment between assignments, incremental grade improvement etc. The formative assessment activities were evaluated and the outcomes were that the mean score of the students was above the passing percentile of 50% in every assessment activity. The quantitative and qualitative findings indicated that the method had a positive but weak impact on learning. The students exhibited poor performance in different assessments due to the English questions, this indicates the liabilities in the design and implementation of the model. The evaluative role of the assessments was also inadequate in comparison to the higher discriminating role of the final examination.

The author proposed a theoretical framework as part of an empirical study (Von Hausswolff, 2021) for understanding how students learn to program. The framework showed the utility of the developed concepts and how to deepen the understanding of these concepts in a definite learning environment. The two developed concepts 'practical thinking' and 'come to an agreement' were the basis of developing the understanding of students' experiences. This empirical study comprised first-year engineering students who were learning text-based programming in Python. The course consisted of 15 lectures, and six mandatory computer labs of two hours each, and also practised programming without a computer. Also, the students were assigned to a number of TAs. The students needed to finish three tasks to pass the course: a written exam after eight weeks, a larger assignment after the exam, and six computer lab assignments before the exam. Most of the students approved the creative and open perception of the course. The paper had a fallback as only one researcher did the collection of empirical data and the students who were interviewed could be biassed.

The major issue with KBL was that the learners often failed to identify where to adequately implement the domain knowledge (Sangster & Wilson, 1991). This induced the need to develop methodologies for students to learn and master their skills as well as knowing how and where to implement these.

To learn efficiently, learners should be taught in such a manner that will help them become an expert in their skills. Project-based learning is a pedagogical approach that has almost made it true that the student learns more from working on projects than from lectures (Bygstad et al., 2009). It has been said that the students learn more by solving a problem in a real-world environment where the teachers play the role of coach. In 2010, the modern PBL approach attracted a large number of students by the statement "Everything I know, I know how to use and where to apply" (Todorova et al., 2010). Nazdri et. al. (Nadzri et al., 2012) proposed that with the passage of time PBL is switching more and more from a traditional teacher-centred approach to a student-centred approach. They said that PBL is a teaching strategy, in which the communication and presentation skills of both participants and the facilitators are vital.

Over time many researchers have put a greater emphasis on Project-based learning, in which it is believed that the students develop skills through the agile exploration of real-world challenges. Vega et. al. (Vega et al., 2013) proposed an incremental approach to PBL called Cupi2. This approach went through a series of phases incrementally which let the students master various programming skills. The implementation of this method increased the average grade of students. The number of students disapproving of computer programming courses had decreased, from 28% to 10%. Meanwhile, it was highly expensive for institutions because it featured the software factory approach. Cupi2 is somewhat similar to the one proposed in this paper. However, Cupi2 did not incrementally develop the contents while developing the project. One particular disadvantage of this approach was that it was extremely costly for the majority of institutions due to its approach to software factory.

Ge et. al. (Ge & Ding, 2012) put forward an approach to transform the theoretical and abstract course contents of Programming Practice course into task-driven cases. The idea was to refine the original data structure teaching content; meanwhile, aiming at students' professional position competence. The methodology concentrated on three main objectives: Professional ability, Social ability and Methodological ability. Students grasped the skills in the process of learning and completing tasks while obtaining suitable knowledge. There is no explanation of results for the methodology so, it isn't certain that the approach is attaining all the goals that it claimed.

With time, many techniques were merged with PBL to increase its effectiveness, one of which is outcome-based education (Dr Indiramma, 2014). It was adopted to teach the theoretical foundation of computation in which the project preparation was done and the outcome was explained and communicated to students. The students were also presented with a list of projects and requirements. The projects were designed with respect to the course structure. Firstly, the students finalised the topics and discussed the steps to be followed to implement the project i.e., the information gathering and requirements. Projects were implemented respectively based on different aspects e.g., simulation, coding or using suitable tools. When the implementation was completed by students, a demonstration and presentation were taken from the students following the report writing. The understanding level and satisfaction of each student displayed that this combined method of PBL and traditional teaching gained more positive points. Since every student has different learning capabilities, some students considered this method a little difficult due to its implementation issues. There were no specified guidelines for the project that students needed to develop. The diversity in those projects made it hard for teachers to standardise the results. An experience report by Mehdi Jazayeri (Jazayeri, 2015) displayed an approach for teaching the course of Introductory programming to software engineering students, in which PBL was combined with a mastery learning approach. Mastery learning is also a pedagogical approach that allows the learner to develop skills in a way where skills are divided into levels of difficulty. Each student must master one skill before mastering the next skill. The course was structured in two phases: a programming mastery phase and a project design phase. The students were allowed in the second phase only if they had mastered the first one. Its main focus was to eliminate the intimidating students which it was able to achieve. The implementation of this method has shown that it helped the strong students more than the weak students as, the motivation in weak students dropped because they performed averagely in the first phase and weren't allowed to take up the rest of the course in the second phase.

Another similar method combined the PBL with Project Management (Fioravanti et al., 2018) for teaching Software Engineering students. The method was introduced to help students face real-life challenges by developing software in the business context. The lectures were dotted with project lessons, so the students learned the theory and then applied it to the project. The feedback of students, conducted through a questionnaire sent by email, demonstrated a positive response. There was an increase in students' motivation (56.0%), students' approval of approach (54.8% agreed and 38.1% partially agreed) and effectiveness of the learning process (26.2% totally agreed and 40.5% partially agreed). The questionnaire illustrated a few drawbacks of this approach as it faced many challenges due to lack of planning, different times of each stage and mainly the integration of projects.

Souza et. al. (Souza et al., 2019) evaluated students' perception towards PBL through feedback by comparing the results of 17 students who were taught under PBL and non-PBL techniques. As for the PBL approach, a software project central to the course was introduced. The project was based on real-world problems and the activities were driven by meaningful questions. The development of the project was divided into scrum sprints. Meanwhile, the students provided evidence of the tasks performed. The instructors mentored the students to attain the goals of the project. Various PBL principles were adapted i.e., driving questions and balance between guidance and freedom of choice etc. The focus was entirely shifted to student-centred teaching. The students taught under this PBL teaching methodology showed positive achievements, they were considered to be more suited for allowing the development of competencies as they learn-by-doing, with higher motivation, and displayed a more active role in the learning process. The students taught under non-PBL were also monitored and the main reason for their negative response was defined under the categories "Project as Learning Tool", "Documentation" and "Development Process". The results and the concreteness of the approach were criticised because they were solely dependent on the surveys filled by the students. There was no output on how the programming skills of students were improved by developing the project taught under the Project-based learning approach.

In recent times, many researchers have found the agile approach to be taught by project-based learning and this has given us many fruitful results due to its iterative nature. One of these techniques (Olayinka & Stannett, 2020) was to teach agile software development where students worked to develop software for clients. The development of these projects is defined in the form of sprints. Students were required to submit a short report at the end of each sprint presenting what they planned to do, what they achieved and the plan for the next sprint. Several students were unaware of different agile terminologies which made it hard to achieve the results that had been planned. Another analogous methodology was set out which was also designed based on the agile approach (Giese et al., 2020) in which students worked on three different, smaller modelling projects, each with a different focus: analysis, high-level and low-level design. The model lacked the basic skill of initiating motivation in the students which happens to be the core advantage of any PBL technique. A similar model was designed using PBL (Sakulvirikitkul et al., 2020) and the concept of agile software development, which consisted of two phases. The students were required to follow the framework of scrum and gave feedback at the end of each sprint. The method was appreciated by many experts who evaluated it and spoke about how it is a flexible approach that develops a good learning potential in students. The model was proposed for all courses but was inapplicable to some of these courses because of their non-divisibility in the form of cycles.

The above-mentioned details are summarised in the form of a research matrix in Table 1.

After analyzing the shortcomings of the recent works, there is an immense need to provide a content-based agile approach. Some of the above-mentioned methodologies promoting agile software development combined with the PBL didn't have any clearly defined iterative learning path. This resulted in the reduction of motivation in the students and therefore they avoided learning the programming courses.

Therefore, in this paper, we propose an agile-based fully mapped project with contents to enhance the programming skills of the students. The iterative method of content delivery with project development defines a learning path that will help students to master the skills, thus increasing their motivation level and helping them in their professional careers. Complete methodology is explained in the next section.

Table 1. Research Matrix

Sr. No.	Reference	PBL	Iterative	Approach	Strength	Weakness
1	Bygstad et. al. (2009)	Yes	Yes	Scaffolding approach	The students learned from achievements instead of failures.	The experimental data are from only one case. (1400 students over 5 years at the Norwegian School of IT).
2	Todorova et. al. (2010)	Yes	No	Traditional lecture-based education combined with project-based learning.	The methodology is based on the preceding course structure which lets the students learn the programming skills in the form of a learning path.	Inadequate timeline. Students were unable to implement the third project.
3	Nadzri et. al. (2012)	Yes	Yes	Sessional approach	The study focused on both hardware & software integration.	No results or evidence on the practical implementation of the approach.
4	Vega et. al. (2013)	Yes	Yes	Integral learning approach - Cupi2	The theory focuses the most on the student's motivation, while they develop programming skills that they can apply in the real world incrementally.	It is highly costly for institutions due to the involvement of software factory.
5	Ge et. al. (2012)	Yes	No	Task-driven approach	This approach focused on students' professional positions by integrating classroom	No results have been shown in the paper to prove the correctness of the proposed method.
6	Dr Indiramma M. (2014)	Yes	No	Outcome-based education aligned with PBL.	study with actual work.	The difference in the students' learning capabilities was not dealt with. Slow learners were unable to do any of the implementations.
7	Jazayeri, M. (2015)	Yes	No	Mastery Learning with PBL.	The paper proved to have successfully met its goal of enhancing the learning outcomes of students.	The approach was unable to achieve its aim which was to eliminate the intimidating students.
8	Fioravanti et. al. (2018)	Yes	No	Phasal approach	The technique focused on the learning capabilities of students. The weak students weren't allowed in the project phase thus, avoiding the unreasonable burden.	No specific path to be followed by the students to achieve their goals.
9	Souza et. al. (2019)	Yes	No	Project-based approach.	The approach was designed in a way where students from all disciplines were able to develop their computing skills.	lack of planning, different times of each stage and mainly the integration of pro-jects.
10	Olayinka et. al. (2020)	Yes	Yes	Agile software development.	The approach focused on developing competencies and motivation in students.	The framework is quite limited to make educators embrace the principles of PBL for practical work.
11	Giese et. al. (2020)	Yes	Yes	Project-based modelling - Model II.	The framework is targeted towards the multicultural dimension.	The method skipped the part where students need to get familiar with various agile terminologies.
12	Sakulvirikitkulet. al. (2020)	Yes	Yes	Agile software development.	The approach focused on early learning successes, personal and regular feedback which displayed the increase in students' participation rate from 40 - 70%.	The implementation of the method failed to develop motivation in students as the majority of students in 2017 were still not ready to further deepen their knowledge in the field.

3. Methodology

In an attempt to bridge the previously mentioned gaps, we proposed the following methodology that will provide the basis of our teaching model.

Project-Based Learning: Firstly, we choose a project for the introductory programming course that will fit the Project-Based Learning approach.

Agile Methodology: Then, we divide the contents of the course in an iterative manner to be taught in the theory class and implement the chosen project iteratively using the concepts learnt in the class

Iterative Development: Lastly, we deliver these contents to the students with respect to the project that has been chosen before. The delivery of these contents' grounds on the following stages:

- Inception
- Elaboration
- Construction
- Transition

The Inception and Elaboration are delivered in the classroom while the Construction and Transition are covered during the lab sessions.

Figure 1 shows the proposed methodology of our Iterative Project Based Teaching Model.

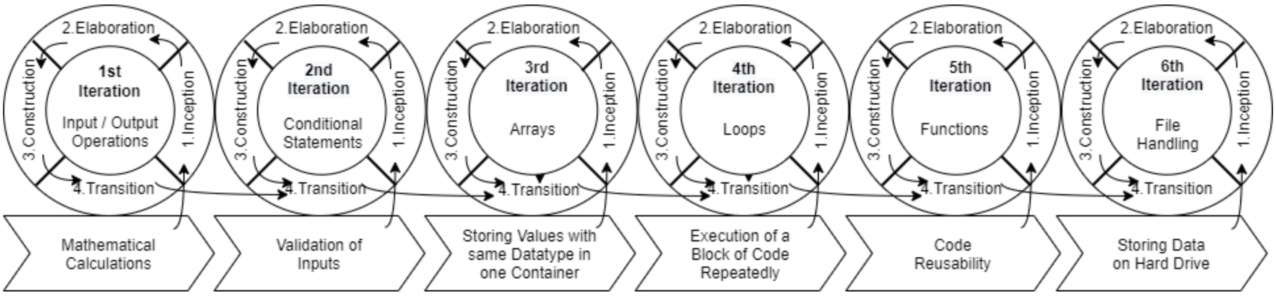

Figure 1 Methodology of Iterative Project Based Teaching Model

Figure 1 shows six iterations that students follow during the first introduction course. In the first class, we show the complete working copy of the chosen project to the students and what they are required to develop throughout the semester in a series of iterations. We divide the project with reference to the above six iterations. We display the requirements to complete the project and brief the students that they will be able to complete this project while achieving the programming skills step by step.

For the development of the project, we stick to the iterative development organised over four phases. This cycle is followed individually for each iteration. Students fulfil the requirements visioned in the Inception phase. Firstly, we provide the students with a vision in the form of requirements related to the task to be performed. These requirements are given as Agile User Stories. Secondly, we design the concepts to be covered according to the task performed by students in the specific iteration in the Elaboration phase. We teach those concepts in the class. Thirdly in the Construction phase, we make students master these concepts by implementing the given task in the computer labs. If the student fails to acquire the required knowledge of the current iteration, then extra time is invested in the construction phase; otherwise, the student moves on to the next phase. Lastly in the Transition phase, we have a discussion session with the students to identify the shortcomings in the project implemented with the current concepts. After identifying the shortcoming, the students are given new requirements that overcome the previous shortcomings. This circle continues, and the shortcomings of the one iteration generate the need for the next iteration.

Figure 2 outlines the overall flow of the proposed teaching model:

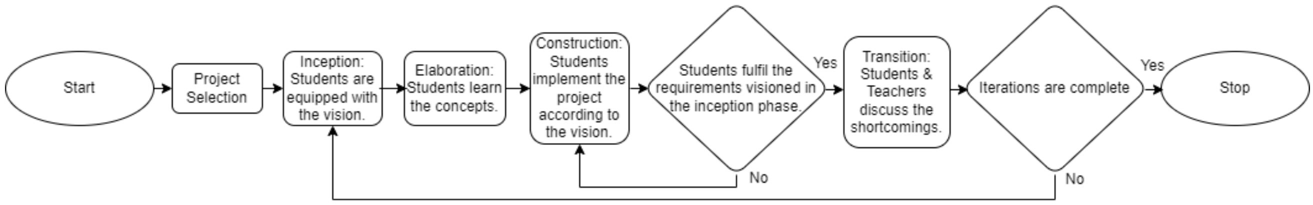

Figure 2 Flow of Iterative Project Based Teaching Model

The whole methodology progresses in the form of an iterative cycle of software development from the first to the last iteration. The students develop the whole project at the end of the semester by completing the smaller subtasks of the bigger project in each iteration and then improving those tasks to make the final project.

3.1. 1st Iteration of Point of Sales Application

Point of Sales is selected for implementation by the students enrolled in the introductory programming course. Figure 3 explains the basic flow of our project-based learning model for the 1st iteration.

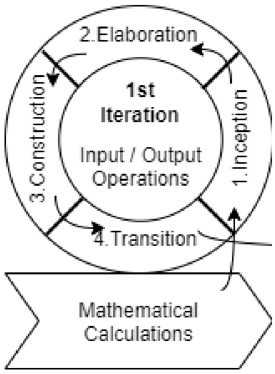

Figure 3 1st Iteration

The students cover a set of stages in each iteration. The stages for 1st iteration according to our model are defined below:

3.1.1 Inception: The students are given the vision as requirements for the first iteration. The description of vision is to convert one form of data (input) into another form of data (output) using mathematical expressions. The students are provided with the agile user stories. So, the students are able to extract the task they have to complete in order to develop the complete project.

Following template of agile user story is followed for the Point of Sales Application (Table 2).

Table 2. Agile User Story for 1st Iteration

Template	Story ID	As an	I want to perform	So that I can
1	9	Admin	Calculate the Price of 5 Products.	Calculate the Price of product w.r.t. it's quantity.

2	10	Admin	Calculate the Total Price of 5 Products.	Calculate the Sum of Prices of the Products bought.
3	11	Admin	Calculate the Total Payable Amount (incl. tax) of 5 Products.	Calculate the Total Payable Amount after adding the tax (5%).

3.1.2. Elaboration: The elaboration phase includes the designing of the project for the 1st iteration i.e., the concepts that will be used while implementing the project according to the vision in the inception phase. These concepts are first taught in the classroom so that students have the required knowledge to develop the project.

Following are the concepts covered in the first iteration (Table 3).

Table 3. Concepts Covered in 1st Iteration

Variables	Variables are used to name the memory locations in which the values are stored. The values can be changed on runtime. All the inputs will be taken into the variables.
Input (cin)	Cin is used to get input from the user through the keyboard into the variables.
Output (cout)	Cout is used to display/print the contents of a program onto the output screen.
Mathematical Expressions (Arithmetic Operators)	Arithmetic operators are used to creating mathematical expressions with variables.

3.1.3. Construction: In the construction phase, the students implement the project according to the vision. The complete output of the task that the student is required to develop is given to the students.

Figure 4 gives the output of the 1st iteration according to the vision.

```
Enter the Price of First Product: 10
Enter the Quantity of First Product: 2
The Price of First Product with respect to its quantity: 20
Enter the Price of Second Product: 15
Enter the Quantity of Second Product: 3
The Price of Second Product with respect to its quantity: 45
Enter the Price of Third Product: 20
Enter the Quantity of Third Product: 4
The Price of Third Product with respect to its quantity: 80
Enter the Price of Fourth Product: 25
Enter the Quantity of Fourth Product: 5
The Price of Fourth Product with respect to its quantity: 125
Enter the Price of Fifth Product: 30
Enter the Quantity of Fifth Product: 6
The Price of Fifth Product with respect to its quantity: 180
Total Price = 450
GST added on Total Payable Amount: 76
Total Payable Amount (incl. tax): 526

--------------------------------
Process exited after 14.61 seconds with return value 0
Press any key to continue . . .
```

Figure 4 Output Screen for 1st Iteration

During the lab session, we make sure that the student has gained the required knowledge with respect to the 1st iteration only then a student is allowed for the transition phase. If not, the student spends extra time to fully grasp the required skills.

3.1.4 Transition: At the end of the iteration, the students and teachers review the project and discuss certain shortcomings in the current iteration. After finding the fallbacks the students will transit to the next iteration, to overcome these shortcomings and further improve the project. The results after the review on the first iteration are given below.

- **No checks:** The user can enter whatever amount or quantity of the products he desires. Even if that quantity or those prices don't exist in the system. e.g., in the above program, a user can enter whichever amount he wants.
- **Sequential Execution:** Programs always run-in sequential order. What if the requirement is to do something if a certain condition is satisfied? e.g., what if a user has entered an invalid input.

This process continues for 6 iterations. In the 6th iteration, the students are provided with the final requirements of the project. In this iteration, students develop the complete project. In the end, the whole project is reviewed and matters are discussed between the students and the teachers.

Appendix-A elaborates the details related to all six iterations of the proposed teaching model including the phases of iterative development process demonstrating the Point of Sales project i.e., description of the vision and corresponding agile user stories, concepts covered in the elaboration phase, sample code snippets and respective output screens of the transition phase and then finally the drawbacks of the iteration in the transition phase.

4. Experimentation

Two undergraduate sessions of students were taught in the introductory course at the Department of Computer Science at The University of Engineering & Technology, Lahore.

- 2019 Session
- 2020 Session

The course plan for both sessions is as follows:

- 3 hours theoretical lectures
- 9 hours practical labs

The 2019 session was taught with the traditional lecture-style (non-PBL) while the 2020 session was taught by the Iterative Project-based Teaching Model (PBL). Both sessions had the strength of 150 students. The 2019 session had 103 male students and 47 female students. The session of 2020 had 94 male students and 56 female students as shown in Table 4.

Table 4. Experimental Dataset

Session	**Methodology**	**Class Size**	**Female Students**	**Male Students**
2019	Non-PBL	150	47	103
2020	PBL	150	56	94

The students of both sessions were taught theoretical lectures of 3 hours. The students of the 2019 batch did practical labs on problem-solving techniques related to independent examples e.g., finding an area of a square, calculating the square root of a number etc. Meanwhile, in the 2020 session's students were given a project (Point of Sales Application) in their first class. The students implemented the skills learned from the theoretical classes to this project in the 6 hours of practical labs. Rest of the 3 hours of lab work was dedicated to real-world problem-solving skills.
Figure 5 outlines the details of the experimentation:

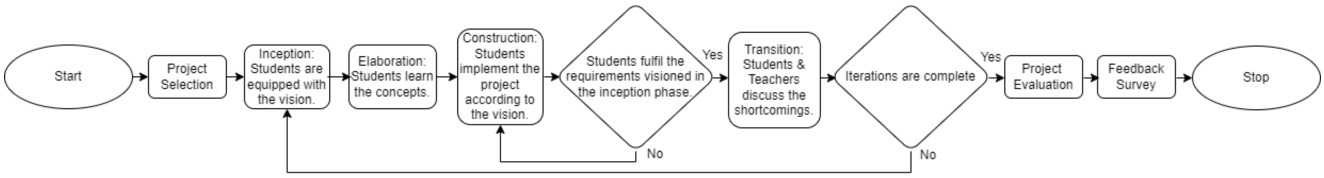

Figure 5 Extended Flow of Iterative Project Based Teaching Model

With the progression of the course, the students were assessed based on quizzes, assignments, mid-term exams, final term, iterative project deliverables, and survey questionnaires. In the end, students of both sessions were given the same Term Project (University Admission Management System) to develop for final evaluation. In this project the students were required to develop the admission management system in which the admin user can add students based on the admission criteria, put certain checks on the data to filter the options and save the records to the hard-disk etc. The proposed PBL approach is evaluated based on two things:

- Levels achieved by students in the development of projects.
- Surveys conducted at the end of the semester.

The students were assessed based on the following levels:

Table 5: Assessment Levels

Beginner Level	The students who were able to change menus along with clearing the previous screen e.g., displaying items on the console.
Moderate Level	The students who were able to perform CRUD operations on the arrays and perform various other functions on the data e.g., Sorting etc.
Expert Level	The students were able to implement the full features of file handling e.g., reading the data from the file as well as writing data from an array into the file.

The conducted survey, for both sessions, was designed to evaluate the student's motivation and satisfaction levels. Students were provided with three choices to express their opinions i.e., Weak, Normal and Strong. Survey questions were categorised as follows: In Q1 students were questioned about their status of motivation. Q2, Q3 & Q4 had targeted the understanding level of the student. Q5, Q6, & Q7 inquired the students regarding the preparations to carry out the enforced teaching method. In Q8 students were asked if the workload was manageable in line with other subjects. Q9 questioned the students about the future they see for themselves and, Q10 implied onto the flexibility of the professor.

The details related to survey questions are given in Appendix-B.

We selected the survey questionnaire as the grounds of feedback analysis from students of both sessions which will help us to improve the effectiveness of our teaching model. We designed the survey questions to receive feedback from students regarding the teaching model e.g., the teacher, their motivation and the workload etc. Both the students of session 2019 and 2020 filled out the survey after the completion of their semester project.

5. Results

The details of the results are given below:

5.1. Project Development Results:

The following bar chart represents the results of Traditional Teaching Style in comparison to Iterative Project-based Teaching Model (Figure 6):

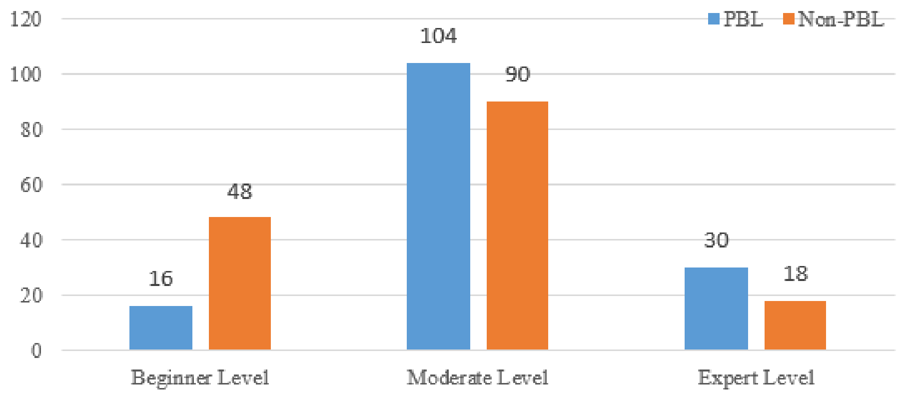

Figure 6 Project Development Results

The above figure shows the number of students on its x-axis and their respective programming levels on the y-axis. The orange colour represents the proposed Iterative Project-based Teaching Model (PBL) while the colour blue represents Traditional Teaching Style (non-PBL). It shows that 69.34% of students taught by PBL, reached the Moderate Level. On the other hand, 60% of students reached the Moderate Level. The session of 2019 (non-PBL) showed poor performance as there were 32% of students who got stuck at only Beginner Level and 12% of students got to reach the Expert Level. 20% of students from the 2020 session reached the Expert Level and only 10.67% of students were evaluated on Beginner Level.

5.2. Survey Results:

Figure 7 and Figure 8 illustrate the surveys conducted by the students of both sessions at the end of the semester:

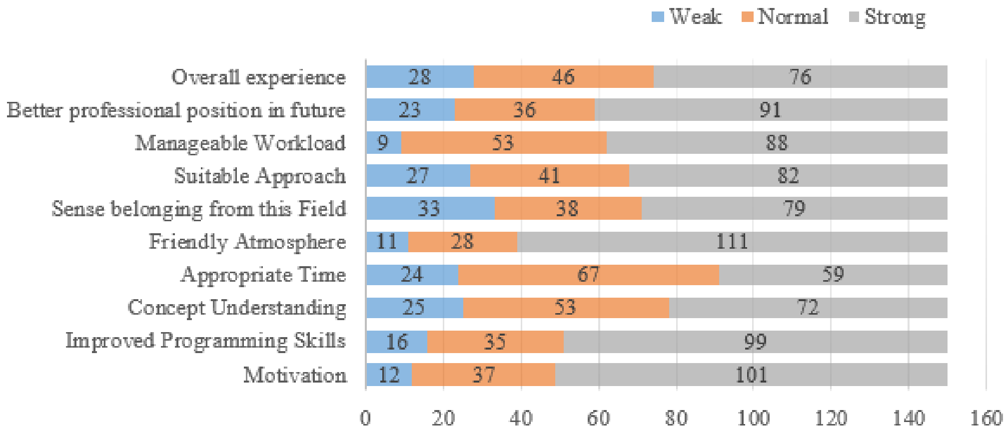

Figure 7 Survey Results of Students taught under PBL

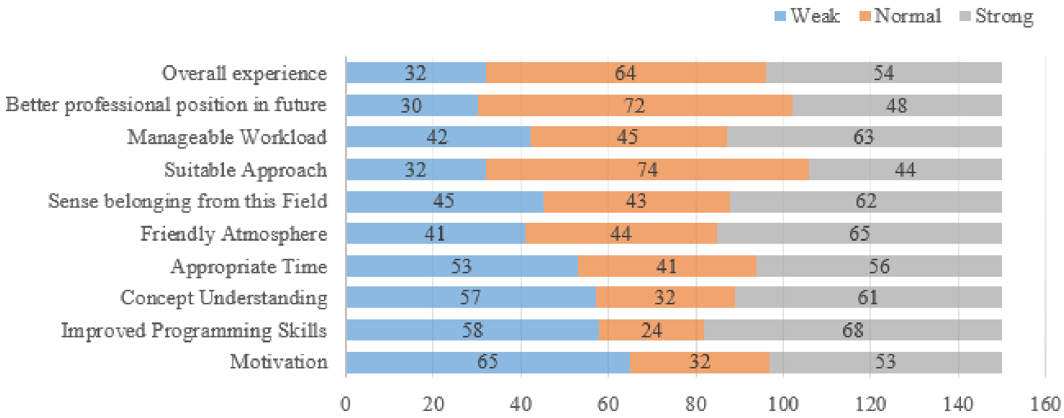

Figure 8 Survey Results of Students taught under non-PBL

Both of the bar charts (Figure 7 and Figure 8) display the number of students on their x-axis and the survey questions on the y-axis. The grey colour represents the number of students who selected the "Strong" choice for their answer, the orange colour shows the number of students who made the "Normal" choice and the blue colour displays the choice "Weak" made by students.

6. Discussion

After a thorough survey of the agile methodologies proposed in the past to teach programming courses with project-based learning, we present the teaching of introductory programming course through an iterative model. Previous methodologies failed to fully cover the gap between the theoretical lectures and their practical implementation. To bridge this gap, we propose a content-based iterative approach to bridge the gap. This new approach teaches the programming constructs to the students by developing the project iteratively.

The presented project-based teaching model collaborates with the content-based agile approach. The contents of the course were delivered through the agile technique in addition to the project to be developed. Six iterations were designed to teach introductory programming courses. These iterations advanced by walking through the four stages of iterative project development. The students were given the requirements to perform a task in the inception phase then, they learned the concepts designed in the elaboration stage. The students implemented the concepts concerning their project in the construction phase. Lastly, in the transition stage, teachers and students had a meeting and reviewed the shortcomings of the current iteration.

The results show that teaching through iteratively mapped projects help students to improve their problem-solving skills based on real-life problems. There has been a rise in motivation when the students identify the improvement in their programming skills. Through the survey questions we have deduced that most of the students taught under PBL have responded positively when they were asked about their future in the field of software development. Developing the projects through this iterative method, students were motivated to plan their future professional positions in the discipline of computer science.

Here, we represent our analysis to the Research Questions defined in the introduction section. The results exhibit the positive outcomes in line of hypothesis based on previously mentioned research questions, as:

First research question was to inquire what possible phases needed to be part of the iterative PBL. The phases of the iterations were designed by following the phases of iterative project development. Each iteration of our teaching model was planned under the inception, elaboration, construction and transition phase. At the transition phase, the teacher and students discussed the shortcomings of the task performed which laid the foundation of the next iteration. The iterations were drafted in a way so that the next iteration could improve and refine the shortcomings of the previous one. In this way, the students developed their skills most adequately.

Second research question was to see the effect of the proposed PBL on the extrinsic and intrinsic motivation of students. The survey conducted by students of both sessions indicated that a large number of students taught under PBL had developed intrinsic motivation due to their mastery of skills in project development. The extrinsic motivation was also high in students of session 2020 because of the iterative project they implemented in the labs. In the session, 2020 students exclaimed that they will be willing to learn more programming languages in the future. They also widely participated during the classrooms both the theoretical deliverables and the labs. On the contrary, the students taught under non-PBL failed to develop an evident motivation because 32% of students got stuck on the beginner level.

7. Conclusion

After performing a detailed analysis of the past studies, we propose an Iterative project-based teaching model, to teach programming course. The presented approach presents the solution to various challenges that were faced while teaching programming languages such as, it makes students learn through a defined learning path, it increases motivation in students and it makes students understand better about where, when and how to use a specific skill. The iterative teaching model has proven through positive results that the students taught under PBL preferred to learn and heighten their knowledge in programming languages than the ones who were taught under non-PBL methodology.

This iterative teaching model can be extended or redeveloped for other senior-level programming courses with minor changes. We intend to evolve this model and propose a similar framework for the course of Object-Oriented Programming taught in the C# (C Sharp) programming language. Future investigations could also include whether any other action or activity i.e., student's previous degree, student's work experience, peer assessment, and instructor participation in resolving the issues faced by students, have an impact on results or not.

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Appendix-A

1st Iteration

1. **Inception:**

Description	Analyse and write computer programs for converting one form of data (input) into another form of data using mathematical expressions.

Agile User Story:

Template	Story ID	As an	I want to	So that I can
1	9	Admin	Calculate the Price of 5 Products.	Calculate the Price of product w.r.t. it's quantity.
2	10	Admin	Calculate the Total Price of 5 Products.	Calculate the Sum of Prices of the Products bought.
3	11	Admin	Calculate the Total Payable Amount (incl. tax) of 5 Products.	Calculate the Total Payable Amount after adding the tax (5%).

2. **Elaboration:**

This iteration will cover the following concepts:

Variables	Variables are used to name the memory locations in which the values are stored. The values can be changed on runtime. All the inputs will be taken into the variables.
Input (cin)	Cin is used to get input from the user through the keyboard into the variables.
Output (cout)	Cout is used to display/print the contents of a program onto the output screen.
Mathematical Expressions (Arithmetic Operators)	Arithmetic operators are used to creating mathematical expressions with variables.

3. **Construction:**

Below is the sample code for 1st iteration:

```cpp
#include<iostream>

using namespace std;

int main()
{
    int prod1, prod2, prod3, prod4, prod5;
    int q1, q2, q3, q4, q5;
    int price1, price2, price3, price4, price5;
    int sumOfPrices;
    int tax, amount, change, paid;

    cout << "Enter the Price of First Product: ";
    // Stores the integer number in variable prod1
    cin >> prod1;

    cout << "Enter the Quantity of First Product: ";
    // Stores the integer number in variable q1
    cin >> q1;

    cout << "The Price of First Product with respect to its quantity: ";
    // Performs multiplication and stores the result in variable price1
    price1 = prod1 * q1;
    cout << price1 <<endl;

   // Performs addition and stores the result in variable sumOfPrices
   sumOfPrices = price1 + price2 + price3 + price4 + price5;

   cout << "Total Price = " << sumOfPrices <<endl;

   // Performs tax calculation and stores the result in variable tax
   tax = sumOfPrices * (17*0.01);

   // Add tax amount into total price and stores the result in variable amount
   amount = sumOfPrices + tax;

   cout << "GST added on Total Payable Amount: " << tax << endl;
   cout << "Total Payable Amount (incl. tax): "<< amount <<endl;

   return 0;
}
```

Complete Screenshot of the task performed:

```
Enter the Price of First Product: 10
Enter the Quantity of First Product: 2
The Price of First Product with respect to its quantity: 20
Enter the Price of Second Product: 15
Enter the Quantity of Second Product: 3
The Price of Second Product with respect to its quantity: 45
Enter the Price of Third Product: 20
Enter the Quantity of Third Product: 4
The Price of Third Product with respect to its quantity: 80
Enter the Price of Fourth Product: 25
Enter the Quantity of Fourth Product: 5
The Price of Fourth Product with respect to its quantity: 125
Enter the Price of Fifth Product: 30
Enter the Quantity of Fifth Product: 6
The Price of Fifth Product with respect to its quantity: 180
Total Price = 450
GST added on Total Payable Amount: 76
Total Payable Amount (incl. tax): 526

--------------------------------
Process exited after 14.61 seconds with return value 0
Press any key to continue . . .
```

4. Transition:

After performing the above task, we find the following drawbacks:

- No checks: The user can enter whatever amount or quantity of the products he desires.

  Even if that quantity or those prices don't exist in the system.

  e.g., in the above program a user can enter whichever amount he wants.
- Sequential Execution: Programs always run in a sequential order. What if the requirement

  is to do something if a certain condition is satisfied?

  e.g., what if a user has entered an invalid input.

From this point on everything will base on the previously written or presented learning skills. In other words, further learning skills will be solely based on all the previously elaborated learning skills making it the extension of the project from one learning skill to another.

2^{nd} Iteration

1. **Inception:**

Description	Analyze and solve computational problems based on single and multiple conditions.

Agile User Story:

Template	Story ID	As an	I want to	So that I can
4	5	Admin	Check the quantity of products (Stock).	Manage the stock in case of shortage of products.
5	8	Admin	Check if the customer entered the valid Choice.	Check if the choice entered by the customer is valid to proceed further.
6	12	Admin	Check if the customer entered a certain choice than a previously specified GST should be applied w.r.t. to that price.	Manage different GSTs w.r.t. to various products.
7	13	Admin	Check the total payable amount of the three products added into the cart.	Manage my order and will only pay for the products that I want to buy.
8	14	Admin	Check if the total payable amount exceeds a certain limit, then they get two gift cards.	Give gift cards to certain customers. So that they can feel satisfied with our services.
9	15	Admin	Check if the customer has bought a combination of two certain products OR a specific quantity of one product then they get a discount on the whole cart.	Give discounts to certain customers. So that they can feel satisfied with our services.

2. **Elaboration:**

This iteration will cover the following concepts:

Conditional statements (if, if-else, if… else-if…else)	Conditional statements are used to change the flow of our program.
Logical Operators (&&, ||, !)	Logical operators are used to combine two or more conditions/constraints.

3. **Construction:**

Below is the sample code for 2^{nd} iteration:

```
// Check wether the choice entered by the customer is valid or not
if (choice1 == 1){
cout << "You selected:" <<endl;
cout << "Product Name: Cheese Product Price: 100" <<endl;
cout << "Please Enter the Quantity of Product: ";
cin >> qty1;
}
else if(choice1 == 2){
cout << "You selected:" <<endl;
cout << "Product Name: Milk Product Price: 120" <<endl;
cout << "Please Enter the Quantity of Product: ";
cin >> qty1;
}
else {
cout << "You entered an Invalid Choice!" <<endl <<endl;
}
//To give discount to customers on certain conditions
if ( (choice1 == 1 && qty1 == 10) || (choice2 == 1  && qty2 == 10) || (choice3 == 1  && qty3 == 10) ){
    cout<< "You got 30% discount on your Cart!" <<endl;
    discount = totalAmount  * (30 * 0.01);
    discountAmount = totalAmount - discount;
    cout << "Your Discounted Total Cart Payable Amount is: " << discountAmount <<endl;
}
```

Complete Screenshot of the task performed:

```
Sr. No.        Product Name          Product Price (per. unit)          Product GST (in %age)

1.             Cheese                      100                          5
2.             Milk                        120                          6
3.             Yogurt                      90                           4
4.             Butter                      150                          8
5.             Cream                       180                          10
6.             Bread                       70                           3
7.             Eggs                        120                          6
8.             Cake                        220                          12

Please enter your Choice: 4
You selected:
Product Name: Butter Product Price: 150
Please Enter the Quantity of Product: 2
Total Price of the Product: 300
GST added is: 24
Total Payable Product Price is: 324
Do you want to Add Product into the Cart? Y/N
Y
Product has been successfully added to Cart!

Please enter your Choice: 3
You selected:
Product Name: Yogurt Product Price: 90
Please Enter the Quantity of Product: 5
Total Price of the Product: 450
GST added is: 18
Total Payable Product Price is: 468
Do you want to Add Product into the Cart? Y/N
Y
Product has been successfully added to Cart!

Please enter your Choice: 1
You selected:
Product Name: Cheese Product Price: 100
Please Enter the Quantity of Product: 5
Total Price of the Product: 500
GST added is: 25
Total Payable Product Price is: 525
Do you want to Add Product into the Cart? Y/N
Y
Product has been successfully added to Cart!

Total Products in Cart: 3

Your 1st Product is: Butter     Quantity: 2          Total: 324
Your 2nd Product is: Yogurt     Quantity: 5          Total: 468
Your 3rd Product is: Cheese     Quantity: 5          Total: 525

Your Total Cart Payable Amount is: 1317
You got 30% discount on your Cart!
Your Discounted Total Cart Payable Amount is: 921.9

--------------------------------
Process exited after 32.16 seconds with return value 0
Press any key to continue . . .
```

4. Transition:

After performing the above task, we find the following drawbacks:

- Large number of variables: We declare a large number of variables to store data of the same type. Thus, using a lot of variables and increasing the compile time of the program.

3rd Iteration

1. Inception:

Description	Analyse and solve complex computational problems involving repetition of dependent and independent iterations.

Agile User Story:

Template	Story ID	As an	I want to perform	So that I can
10	2	Admin	View the list of products.	Keep record of which products to add or remove.
11	3	Admin	Add new products to the previously existing list.	Keep the application growing.
12	4	Admin	Edit the details of products.	Manage the details of various products.
13	6	Admin	Remove products from the previously existing list.	Remove outdated items.

2. Elaboration:

This iteration will cover the following concepts:

Arrays	The arrays are used to store multiple values of the same datatype. Each element of an array can individually be referred to according to the need.

3. Construction:

Below is the sample code for 3rd iteration:

```
string productName[] = {"Cheese", "Milk", "Yogurt", "Butter", "Cream", "Bread", "Eggs", "Cake", "NULL"};
int productPrice[] = {100, 120, 90,150, 180, 70, 120, 220, 0};
float productGst [] = {5, 6, 4, 8, 10, 3, 6, 12, 0};
cout << "Sr. No.        Product Name        Product Price (per. unit)        Product GST (in %age)" <<endl <<endl;

cout << "1.     "        << productName[0] << "        " << productPrice[0] << "        " << productGst[0] <<endl;
cout << "2.     "        << productName[1] << "        " << productPrice[1] << "        " << productGst[1] <<endl;
cout << "3.     "        << productName[2] << "        " << productPrice[2] << "        " << productGst[2] <<endl;
cout << "4.     "        << productName[3] << "        " << productPrice[3] << "        " << productGst[3] <<endl;
cout << "5.     "        << productName[4] << "        " << productPrice[4] << "        " << productGst[4] <<endl;
cout << "6.     "        << productName[5] << "        " << productPrice[5] << "        " << productGst[5] <<endl;
cout << "7.     "        << productName[6] << "        " << productPrice[6] << "        " << productGst[6] <<endl;
cout << "8.     "        << productName[7] << "        " << productPrice[7] << "        " << productGst[7] <<endl;

cout << "9.     "        << productName[8] << "        " << productPrice[8] << "        " << productGst[8] <<endl <<endl;
```

Complete Screenshot of the task performed:

```
1.          View List of Products
2.          Add Product
3.          Update Product
4.          Delete Product
5.          Customer
6.          Log Out

Enter '1' to View List of Products: 1
Sr. No.     Product Name        Product Price (per. unit)       Product GST (in %age)

1.          Cheese                   100                          5
2.          Milk                     120                          6
3.          Yogurt                   90                           4
4.          Butter                   150                          8
5.          Cream                    180                          10
6.          Bread                    70                           3
7.          Eggs                     120                          6
8.          Cake                     220                          12
Enter '2' to Add Product: 2
Enter Product Name: Muffin
Enter Product Price: 40
Enter Product GST: 2
Sr. No.     Product Name        Product Price (per. unit)       Product GST (in %age)

1.          Cheese                   100                          5
2.          Milk                     120                          6
3.          Yogurt                   90                           4
4.          Butter                   150                          8
5.          Cream                    180                          10
6.          Bread                    70                           3
7.          Eggs                     120                          6
8.          Cake                     220                          12
9.          Muffin                   40                           2
```

```
Enter '3' to Update Product: 3
Sr. No.         Product Name            Product Price (per. unit)               Product GST (in %age)

1.              Cheese                          100                             5
2.              Milk                            120                             6
3.              Yogurt                          90                              4
4.              Butter                          150                             8
5.              Cream                           180                             10
6.              Bread                           70                              3
7.              Eggs                            120                             6
8.              Cake                            220                             12
9.              Muffin                          40                              2
Enter Sr. No. of Product you want to update: 4
Which one do you want to Update?
1.              Product Name
2.              Product Price
3.              Product GST
Enter your Choice: 2
Enter Product Price: 160
Sr. No.         Product Name            Product Price (per. unit)               Product GST (in %age)

1.              Cheese                          100                             5
2.              Milk                            120                             6
3.              Yogurt                          90                              4
4.              Butter                          160                             8
5.              Cream                           180                             10
6.              Bread                           70                              3
7.              Eggs                            120                             6
8.              Cake                            220                             12
9.              Muffin                          40                              2

Enter '4' to Delete Product: 4
Sr. No.         Product Name            Product Price (per. unit)               Product GST (in %age)

1.              Cheese                          100                             5
2.              Milk                            120                             6
3.              Yogurt                          90                              4
4.              Butter                          160                             8
5.              Cream                           180                             10
6.              Bread                           70                              3
7.              Eggs                            120                             6
8.              Cake                            220                             12
9.              Muffin                          40                              2
Enter Sr. No. you want to Delete: 3
Sr. No.         Product Name            Product Price (per. unit)               Product GST (in %age)

1.              Cheese                          100                             5
2.              Milk                            120                             6
3.              NULL                            0                               0
4.              Butter                          160                             8
5.              Cream                           180                             10
6.              Bread                           70                              3
7.              Eggs                            120                             6
8.              Cake                            220                             12
9.              Muffin                          40                              2
Enter '5' to Add a Customer: 5
Sr. No.         Product Name            Product Price (per. unit)               Product GST (in %age)
1.              Cheese                          100                             5
2.              Milk                            120                             6
3.              NULL                            0                               0
4.              Butter                          160                             8
5.              Cream                           180                             10
6.              Bread                           70                              3
7.              Eggs                            120                             6
8.              Cake                            220                             12
9.              Muffin                          40                              2

Please enter your Choice: 2
You selected:
Product Name: Milk Product Price: 120
Please Enter the Quantity of Product: 2
Total Price of the Product: 240
GST added is: 14.4
Total Payable Product Price is: 254.4
Do you want to Add Product into the Cart? Y/N
y
Product has been successfully added to Cart!

Please enter your Choice: 6
You selected:
Product Name: Bread Product Price: 70
Please Enter the Quantity of Product: 1
Total Price of the Product: 70
GST added is: 2.1
Total Payable Product Price is: 72.1
Do you want to Add Product into the Cart? Y/N
y
Product has been successfully added to Cart!

Please enter your Choice: 9
You selected:
Product Name: Muffin Product Price: 40
Please Enter the Quantity of Product: 1
Total Price of the Product: 40
GST added is: 0.8
Total Payable Product Price is: 40.8
Do you want to Add Product into the Cart? Y/N
y
Product has been successfully added to Cart!

Total Products in Cart: 3

Your 1st Product is: Milk       Quantity: 2             Total: 254.4
Your 2nd Product is: Bread      Quantity: 1             Total: 72.1
Your 3rd Product is: Muffin     Quantity: 1             Total: 40.8

Your Total Cart Payable Amount is: 367.3
Order Processed Successfully!
Please visit our Store again!
Enter '6' to Log Out: 6
Do you want to Log Out?
1. Yes
2. No
1
You Logged Out Successfully!

You Exited Successfully!
--------------------------------
Process exited after 99.67 seconds with return value 0
Press any key to continue . . .
```

4. Transition:

After performing the above task, we find the following drawbacks:

- Specified Operations: We need the user to choose from the menu repeatedly.

- Code Repetition: We are writing the same code multiple times.

4th Iteration

1. Inception:

Description	Analyse and solve complex computational problems involving large amounts of data.

Agile User Story:

Template	Story ID	As an	I want to perform	So that I can
14	16	Admin	Purchase the products as much as he wants.	Purchase the desired products without any limitation.
15	17	Admin	View the Orders List (Sales Record).	Perform various tasks on the Orders List. e.g., Calculate the customer purchases or finding the marketing information.
16	18	Admin	View the sorted list of Orders (based on the customer's total bill).	Manage the customers in the Orders List.
17	19	Admin	View the High Value Customer (based on the number of times a customer visited).	Find the High Value Customers in the Orders List.
18	20	Admin	View the Monthly Income.	Estimate the Profit or Loss of my store.

2. Elaboration:

This iteration will cover the following concepts:

Loops (for, while, do…while)	The loops are used to execute a block of code repeatedly based on the satisfaction of a particular condition.

3. Construction:

Below is the sample code for 4th iteration:

```
//To Calculate Purchase Price with 5 percent Sales Margin
for (int i = 0; i < 9; i++)
{
    purchasePrice[i] = productPrice[i] - (productPrice[i] * 0.05);
}

for (int i = 0; i < 9; i++)
{
    cout << i + 1 << ".     " << productName[i] << "            " << productPrice[i] << "             " << productGst[i];
    if (stock[i] > 0)
    {
        cout << "          Available" << endl;
    }
    else
    {
        cout << "          Out of Stock" << endl;
    }
}
```

Complete Screenshot of the task performed:

```
*************************************************************************************************************************
********************************************* Ecommerce Application *****************************************************
*************************************************************************************************************************
Enter Username: drawais
Enter Password: 999
1.              View List of Products
2.              Add Product
3.              Update Product
4.              Delete Product
5.              Customer
6.              Orders
7.              Log Out
Please enter your choice: 5
1.              Sign Up
2.              Login
Please enter your choice: 1
Sr. No.         Product Name            Product Price(/unit)            Product GST(%age)       Availability
1.              Cheese                  100                             5                       Available
2.              Milk                    120                             6                       Available
3.              Yogurt                  90                              4                       Available
4.              Butter                  150                             8                       Available
5.              Cream                   180                             10                      Available
6.              Bread                   70                              3                       Available
7.              Eggs                    120                             6                       Available
8.              Cake                    220                             12                      Available
Please enter your choice: 2
Please enter your quantity: 3
Do you want to Add Product into the Cart? Y/N
y
Total Price of the Product: 360
GST added is: 21.6
Total Payable Product Price is: 381.6
Do you want to add another Product? Y/N
y
Please enter your Choice: 5
Please enter your quantity: 3
Do you want to Add Product into the Cart? Y/N
y
Total Price of the Product: 540
GST added is: 54
Total Payable Product Price is: 594
Do you want to add another Product? Y/N
n
Your Product:Milk       Quantity: 3             Total: 381.6

Your Product:Cream      Quantity: 3             Total: 594

Your Total Cart Payable Amount is: 975.6
1.              View List of Products
2.              Add Product
3.              Update Product
4.              Delete Product
5.              Customer
6.              Orders
7.              Log Out
Please enter your choice: 6
Sr.#     Date                   CustomerID    Admin             Bill Description
1.       August 22, 2021        1001          drawais           |Milk=2|Yogurt=1|Eggs=12||| Total = 475.2
2.       August 16, 2021        1002          kashmala          |Cake=1|Butter=2|Eggs=24|Milk=1||| Total = 856.8
3.       August 17, 2021        1003          mahnoor           |Yogurt=2|Milk=1||| Total = 314.4
4.       August 17, 2021        1004          drawais           |Milk=2|Butter=2|Bread=1||| Total = 650.5
5.       August 18, 2021        1005          kashmala          |Butter=1|Cream=1|Cheese=1|Milk=3||| Total = 325
6.       August 18, 2021        1006          kashmala          |Milk=2|Cheese=4||| Total = 674.4

1. Sort the Order List (Total Bill High to Low)
2. Find the High Value Customer
3. Find Monthly Income
Please enter your choice:
1.              View List of Products
2.              Add Product
3.              Update Product
4.              Delete Product
5.              Customer
6.              Orders
7.              Log Out
Please enter your choice: 6
Sr.#     Date                   CustomerID    Admin             Bill Description
1.       August 22, 2021        1001          drawais           |Milk=2|Yogurt=1|Eggs=12||| Total = 475.2
2.       August 16, 2021        1002          kashmala          |Cake=1|Butter=2|Eggs=24|Milk=1||| Total = 856.8
3.       August 17, 2021        1003          mahnoor           |Yogurt=2|Milk=1||| Total = 314.4
4.       August 17, 2021        1004          drawais           |Milk=2|Butter=2|Bread=1||| Total = 650.5
5.       August 18, 2021        1005          kashmala          |Butter=1|Cream=1|Cheese=1|Milk=3||| Total = 325
6.       August 18, 2021        1006          kashmala          |Milk=2|Cheese=4||| Total = 674.4

1. Sort the Order List (Total Bill High to Low)
2. Find the High Value Customer
3. Find Monthly Income
Please enter your choice: 1
Sr.#     Date                   CustomerID    Admin             Bill Description
1.       August 16, 2021        1002          kashmala          |Cake=1|Butter=2|Eggs=24|Milk=1||| Total = 856.8
2.       August 18, 2021        1006          kashmala          |Milk=2|Cheese=4||| Total = 674.4
3.       August 17, 2021        1004          drawais           |Milk=2|Butter=2|Bread=1||| Total = 650.5
4.       August 22, 2021        1001          drawais           |Milk=2|Yogurt=1|Eggs=12||| Total = 475.2
5.       August 18, 2021        1005          kashmala          |Butter=1|Cream=1|Cheese=1|Milk=3||| Total = 325
6.       August 17, 2021        1003          mahnoor           |Yogurt=2|Milk=1||| Total = 314.4

Do you want to make another Choice?
1. Yes
2. No
1.              View List of Products
2.              Add Product
3.              Update Product
4.              Delete Product
5.              Customer
6.              Orders
7.              Log Out
Please enter your choice: 6
Sr.#     Date                   CustomerID    Admin             Bill Description
1.       August 22, 2021        1001          drawais           |Milk=2|Yogurt=1|Eggs=12||| Total = 475.2
2.       August 16, 2021        1002          kashmala          |Cake=1|Butter=2|Eggs=24|Milk=1||| Total = 856.8
3.       August 17, 2021        1003          mahnoor           |Yogurt=2|Milk=1||| Total = 314.4
4.       August 17, 2021        1004          drawais           |Milk=2|Butter=2|Bread=1||| Total = 650.5
5.       August 18, 2021        1005          kashmala          |Butter=1|Cream=1|Cheese=1|Milk=3||| Total = 325
6.       August 18, 2021        1006          kashmala          |Milk=2|Cheese=4||| Total = 674.4
7.       September 19, 2021     1007          drawais           |Butter=2||| Total = 324
8.       September 19, 2021     1003          drawais           |Cream=3|Butter=2||| Total = 918
```

```
1. Sort the Order List (Total Bill High to Low)
2. Find the High Value Customer
3. Find Monthly Income
Please enter your choice: 2

High Value Customer's ID': 1003
1.              View List of Products
2.              Add Product
3.              Update Product
4.              Delete Product
5.              Customer
6.              Orders
7.              Log Out
Please enter your choice: 6
Sr.#     Date                  CustomerID    Admin           Bill Description
1.       August 22, 2021       1001          drawais         |Milk=2|Yogurt=1|Eggs=12||| Total = 475.2
2.       August 16, 2021       1002          kashmala        |Cake=1|Butter=2|Eggs=24|Milk=1||| Total = 856.8
3.       August 17, 2021       1003          mahnoor         |Yogurt=2|Milk=1||| Total = 314.4
4.       August 17, 2021       1004          drawais         |Milk=2|Butter=2|Bread=1||| Total = 650.5
5.       August 18, 2021       1005          kashmala        |Butter=1|Cream=1|Cheese=1|Milk=3||| Total = 325
6.       August 18, 2021       1006          kashmala        |Milk=2|Cheese=4||| Total = 674.4
7.       September 19, 2021    1007          drawais         |Butter=2||| Total = 324
8.       September 19, 2021    1003          drawais         |Cream=3|Butter=2||| Total = 918

1. Sort the Order List (Total Bill High to Low)
2. Find the High Value Customer
3. Find Monthly Income
Please enter your choice: 3

Total Price of Purchased Stock: 88217
Total Price of Sold Stock: 4538.3
Monthly Instatement: -83678.7

Do you want to make another Choice?
1. Yes
2. No
```

4. **Transition:**

After performing the above task, we find the following drawbacks:

- Code Readability: Difficult to read the code because of its complexity.
- Maintenance: Difficult to maintain the code in the same place.
- Testing: If a part of code needs to be tested then the complete program is executed.

5th Iteration

1. **Inception:**

Description	Analyse and solve complex computational problems by decomposing into reusable blocks of code.

Agile User Story:

Template	Story ID	As an	I want to perform	So that I can
19	1	Admin	Login into the system.	Prevent unauthorised users from logging in as Administrator. AND Perform various operations.
20	23	Admin	Logout of the system.	Exit the system and prevent unauthorised users from logging in as Administrator.
21	7	Admin	Add a customer into the system.	Maintain record of the upcoming customers.

2. **Elaboration:**

This iteration will cover the following concepts:

Functions (Built-in, User-defined)	Functions are used to increase the reusability of code i.e., define the code once and use it as many times as wanted.

3. **Construction:**

Below is the sample code for 5th iteration:

```
int logIn(string *userName, string *password)
{
    string adminUserName = "drawais", adminPassword = "999";
    string adminUserName1 = "kashmala", adminPassword1 = "111";
    string adminUserName2 = "mahnoor", adminPassword2 = "222";

    cout << "Enter Username: ";
    cin >> *userName;
    cout << "Enter Password: ";
    cin >> *password;

    if (*userName == adminUserName && *password == adminPassword ||
        *userName == adminUserName1 && *password == adminPassword1 ||
        *userName == adminUserName2 && *password == adminPassword2)
    {
        return 1;
    }
    else
    {
        return 0;
    }
}
```

In main () function the above function will be called as follows:

```
success = logIn(userName, password, i);
```

Complete Screenshot of the task performed:

```
***********************************************************************************************
*************************************** Ecommerce Application ********************************
***********************************************************************************************
Enter Username: drawais
Enter Password: 999
1.              View List of Products
2.              Add Product
3.              Update Product
4.              Delete Product
5.              Customer
6.              Orders
7.              Log Out
Please enter your choice:
1.              View List of Products
2.              Add Product
3.              Update Product
4.              Delete Product
5.              Customer
6.              Orders
7.              Log Out
Please enter your choice: 5
1.              Sign Up
2.              Login
Please enter your choice: 1
Sr. No.         Product Name            Product Price(/unit)            Product GST(%age)       Availability
1.              Cheese                  100                             5                       Available
2.              Milk                    120                             6                       Available
3.              Yogurt                  90                              4                       Available
4.              Butter                  150                             8                       Available
5.              Cream                   180                             10                      Available
6.              Bread                   70                              3                       Available
7.              Eggs                    120                             6                       Available
8.              Cake                    220                             12                      Available
Please enter your choice: 2
Please enter your quantity: 3
Do you want to Add Product into the Cart? Y/N
y
Total Price of the Product: 360
GST added is: 21.6
Total Payable Product Price is: 381.6
Do you want to add another Product? Y/N
y
Total Price of the Product: 360
GST added is: 21.6
Total Payable Product Price is: 381.6
Do you want to add another Product? Y/N
y
Please enter your Choice: 5
Please enter your quantity: 3
Do you want to Add Product into the Cart? Y/N
y
Total Price of the Product: 540
GST added is: 54
Total Payable Product Price is: 594
Do you want to add another Product? Y/N
n
Your Product:Milk       Quantity: 3             Total: 381.6

Your Product:Cream      Quantity: 3             Total: 594

Your Total Cart Payable Amount is: 975.6
1.              View List of Products
2.              Add Product
3.              Update Product
4.              Delete Product
5.              Customer
6.              Orders
7.              Log Out
Please enter your choice: 7
Do you want to Log Out?
1. Yes
2. No
1
***********************************************************************************************
*************************************** Ecommerce Application ********************************
***********************************************************************************************
Enter Username:
```

4. Transition:

After performing the above task, we find the following drawbacks:

- No Permanent Storage: There is no record keeping in the system up until now. If the Admin adds a customer into the system, then the data related to it can't be viewed once the program is closed.

6th Iteration

1. **Inception:**

Description	Analyse and solve complex computational problems by using persistently stored data.

Agile User Story:

Template	Story ID	As an	I want to perform	So that I can
22	21	Admin	Read orders from the CSV file.	List down the customers who have visited in the past.
23	22	Admin	Write the new customers data in the file.	Keep record of all the upcoming customers.

2. **Elaboration:**

This iteration will cover the following concepts:

File Handling	To use various elements of file handling in our program to read data from the file into the arrays and then display it on the output screen. As well as, to write data from the arrays to the file.

3. **Construction:**

Below is the sample code for 6th iteration:

```
void readDataIntoArray(string serial[], string date[], string year[], string customerId[],
    string admin[], string dscrp[], string total[], int size){
    string data("orders.csv");
    ifstream in(data.c_str());
    if (!in.is_open()) return;
    string line;
    int index = 0;
    while (getline(in,line))
    {
        serial[index] = getColumnData(line, 0);
        date[index] = getColumnData(line, 1);
        year[index] = getColumnData(line, 2);
        customerId[index] = getColumnData(line, 3);
        admin[index] = getColumnData(line, 4);
        dscrp[index] = getColumnData(line, 5);
        total[index] = getColumnData(line, 6);
        index++;
    }

}
```

```cpp
// file pointer
fstream fout;

// opens an existing csv file or creates a new file.
fout.open("orders.csv", ios::out | ios::app);

// Read the input
for (int i = 0; i < 20; i++)
{
    // ',' is used to go to next column in same row & '\n' is used to go to next row
    // Insert the data to file

    if (i = 19)
    {
        fout<< "19"<< "," <<date[i]<< year[i]<< "," <<customerId[i]<< "," <<admin[i] << "," << "|";

        //print products with quantities
        for (int j = 0; j < 8; j++)
        {
            if (prod1[j] != "NULL")
            {
                fout << prod1[j] << "=" << qty1[j] << "|" ;
            }
        }
    }
```

Complete Screenshot of the task performed:

```
1.              View List of Products
2.              Add Product
3.              Update Product
4.              Delete Product
5.              Customer
6.              Orders
7.              Log Out
Please enter your choice: 6
Sr.#     Date                 CustomerID    Admin            Bill Description
1.       August 15,2021       1001          drawais          |Milk=2|Yogurt=1|Eggs=12||| Total = 475.2
2.       August 16,2021       1002          kashmala         |Cake=1|Butter=2|Eggs=24|Milk=1||| Total = 856.8
3.       August 17,2021       1003          mahnoor          |Yogurt=2|Milk=1||| Total = 314.4
4.       August 17,2021       1004          drawais          |Milk=2|Butter=2|Bread=1||| Total = 650.5
5.       August 18,2021       1005          kashmala         |Butter=1|Cream=1|Cheese=1|Milk=3||| Total = 325
6.       August 18,2021       1006          kashmala         |Milk=2|Cheese=4||| Total = 674.4
7.       August 23,2021       1007          kashmala         |Cream=2|Cake=3||| Total = 1135.2
8.       August 24,2021       1008          mahnoor          |Bread=3|Eggs=3|Cake=7||| Total = 1972.9
9.       August 26,2021       1003          drawais          |Bread=2|Eggs=2|Cake=4||| Total = 1384.2
10.      August 26,2021       1009          kashmala         |Eggs=3|Butter=5||| Total = 1072.44
11.      August 27,2021       1007          kashmala         |Cream=5|Eggs=12||| Total = 2516.4
12.      August 27,2021       1006          kashmala         |Eggs=3|Butter=6|Milk=6||| Total = 1905.12
13.      August 27,2021       1001          mahnoor          |Yogurt=6||| Total = 561.6
14.      August 28,2021       1006          kashmala         |Bread=8|Yogurt=6||| Total = 1138.4
15.      August 28,2021       1010          mahnoor          |Bread=3|Eggs=12|Cake=1||| Total = 1989.1
16.      August 29,2021       1004          drawais          |Eggs=5|Cheese=2||| Total = 846
17.      August 29,2021       1008          kashmala         |Butter=2|Bread=3|Cake=1||| Total = 786.7
18.      August 29,2021       1006          kashmala         |Milk=2|Cheese=4||| Total = 674.4
```

Meanwhile the CSV file looked like this:

orders - Excel

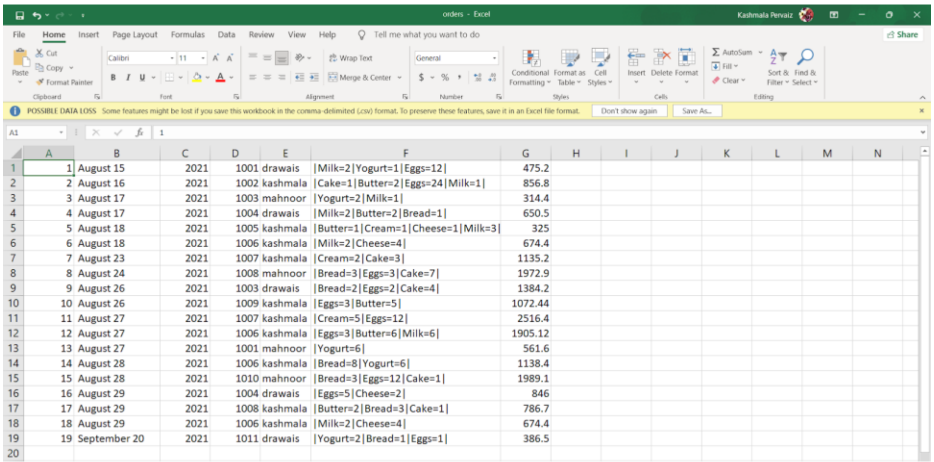
POSSIBLE DATA LOSS Some features might be lost if you save this workbook in the comma-delimited (.csv) format. To preserve these features, save it in an Excel file format.

<table>
<tr><th></th><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th><th>F</th><th>G</th></tr>
<tr><td>1</td><td>1</td><td>August 15</td><td>2021</td><td>1001</td><td>drawais</td><td>|Milk=2|Yogurt=1|Eggs=12|</td><td>475.2</td></tr>
<tr><td>2</td><td>2</td><td>August 16</td><td>2021</td><td>1002</td><td>kashmala</td><td>|Cake=1|Butter=2|Eggs=24|Milk=1|</td><td>856.8</td></tr>
<tr><td>3</td><td>3</td><td>August 17</td><td>2021</td><td>1003</td><td>mahnoor</td><td>|Yogurt=2|Milk=1|</td><td>314.4</td></tr>
<tr><td>4</td><td>4</td><td>August 17</td><td>2021</td><td>1004</td><td>drawais</td><td>|Milk=2|Butter=2|Bread=1|</td><td>650.5</td></tr>
<tr><td>5</td><td>5</td><td>August 18</td><td>2021</td><td>1005</td><td>kashmala</td><td>|Butter=1|Cream=1|Cheese=1|Milk=3|</td><td>325</td></tr>
<tr><td>6</td><td>6</td><td>August 18</td><td>2021</td><td>1006</td><td>kashmala</td><td>|Milk=2|Cheese=4|</td><td>674.4</td></tr>
<tr><td>7</td><td>7</td><td>August 23</td><td>2021</td><td>1007</td><td>kashmala</td><td>|Cream=2|Cake=3|</td><td>1135.2</td></tr>
<tr><td>8</td><td>8</td><td>August 24</td><td>2021</td><td>1008</td><td>mahnoor</td><td>|Bread=3|Eggs=3|Cake=7|</td><td>1972.9</td></tr>
<tr><td>9</td><td>9</td><td>August 26</td><td>2021</td><td>1003</td><td>drawais</td><td>|Bread=2|Eggs=2|Cake=4|</td><td>1384.2</td></tr>
<tr><td>10</td><td>10</td><td>August 26</td><td>2021</td><td>1009</td><td>kashmala</td><td>|Eggs=3|Butter=5|</td><td>1072.44</td></tr>
<tr><td>11</td><td>11</td><td>August 27</td><td>2021</td><td>1007</td><td>kashmala</td><td>|Cream=5|Eggs=12|</td><td>2516.4</td></tr>
<tr><td>12</td><td>12</td><td>August 27</td><td>2021</td><td>1006</td><td>kashmala</td><td>|Eggs=3|Butter=6|Milk=6|</td><td>1905.12</td></tr>
<tr><td>13</td><td>13</td><td>August 27</td><td>2021</td><td>1001</td><td>mahnoor</td><td>|Yogurt=6|</td><td>561.6</td></tr>
<tr><td>14</td><td>14</td><td>August 28</td><td>2021</td><td>1006</td><td>kashmala</td><td>|Bread=8|Yogurt=6|</td><td>1138.4</td></tr>
<tr><td>15</td><td>15</td><td>August 28</td><td>2021</td><td>1010</td><td>mahnoor</td><td>|Bread=3|Eggs=12|Cake=1|</td><td>1989.1</td></tr>
<tr><td>16</td><td>16</td><td>August 29</td><td>2021</td><td>1004</td><td>drawais</td><td>|Eggs=5|Cheese=2|</td><td>846</td></tr>
<tr><td>17</td><td>17</td><td>August 29</td><td>2021</td><td>1008</td><td>kashmala</td><td>|Butter=2|Bread=3|Cake=1|</td><td>786.7</td></tr>
<tr><td>18</td><td>18</td><td>August 29</td><td>2021</td><td>1006</td><td>kashmala</td><td>|Milk=2|Cheese=4|</td><td>674.4</td></tr>
</table>

To add a new customer's data in the .csv file.

```
1.              View List of Products
2.              Add Product
3.              Update Product
4.              Delete Product
5.              Customer
6.              Orders
7.              Log Out
Please enter your choice: 5
1.              Sign Up
2.              Login
Please enter your choice: 1
Your ID: 1011
Sr. No.         Product Name            Product Price(/unit)            Product GST(%age)       Availability
1.              Cheese                  100                             5                       Available
2.              Milk                    120                             6                       Available
3.              Yogurt                  90                              4                       Available
4.              Butter                  150                             8                       Available
5.              Cream                   180                             10                      Available
6.              Bread                   70                              3                       Available
7.              Eggs                    120                             6                       Available
8.              Cake                    220                             12                      Available
Please enter your choice: 3
Please enter your quantity: 2
Do you want to Add Product into the Cart? Y/N
y
Total Price of the Product: 180
GST added is: 7.2
Total Payable Product Price is: 187.2
Do you want to add another Product? Y/N
y
Please enter your Choice: 6
Please enter your quantity: 1
Do you want to Add Product into the Cart? Y/N
y
Total Price of the Product: 70
GST added is: 2.1
Total Payable Product Price is: 72.1
Do you want to add another Product? Y/N
y
Please enter your Choice: 7
Please enter your quantity: 1
Do you want to Add Product into the Cart? Y/N
y
Total Price of the Product: 120
GST added is: 7.2
Total Payable Product Price is: 127.2
Do you want to add another Product? Y/N
n
Your Product:Yogurt     Quantity: 2             Total: 187.2

Your Product:Bread      Quantity: 1             Total: 72.1

Your Product:Eggs       Quantity: 1             Total: 127.2

Your Total Cart Payable Amount is: 386.5

Do you want to keep this in Record?
1. Yes
2. No
1
Record Saved Successfully!

Do you want to make another Choice?
1. Yes
2. No
1
1.              View List of Products
2.              Add Product
3.              Update Product
4.              Delete Product
5.              Customer
6.              Orders
7.              Log Out
Please enter your choice: 6
Sr.#    Date                    CustomerID      Admin           Bill Description
1.      August 15,2021          1001            drawais         |Milk=2|Yogurt=1|Eggs=12||| Total = 475.2
2.      August 16,2021          1002            kashmala        |Cake=1|Butter=2|Eggs=24|Milk=1||| Total = 856.8
3.      August 17,2021          1003            mahnoor         |Yogurt=2|Milk=1||| Total = 314.4
4.      August 17,2021          1004            drawais         |Milk=2|Butter=2|Bread=1||| Total = 650.5
5.      August 18,2021          1005            kashmala        |Butter=1|Cream=1|Cheese=1|Milk=3||| Total = 325
6.      August 18,2021          1006            kashmala        |Milk=2|Cheese=4||| Total = 674.4
7.      August 23,2021          1007            kashmala        |Cream=2|Cake=3||| Total = 1135.2
8.      August 24,2021          1008            mahnoor         |Bread=3|Eggs=3|Cake=7||| Total = 1972.9
9.      August 26,2021          1003            drawais         |Bread=2|Eggs=2|Cake=4||| Total = 1384.2
10.     August 26,2021          1009            kashmala        |Eggs=3|Butter=5||| Total = 1072.44
11.     August 27,2021          1007            kashmala        |Cream=5|Eggs=12||| Total = 2516.4
12.     August 27,2021          1006            kashmala        |Eggs=3|Butter=6|Milk=6||| Total = 1905.12
13.     August 27,2021          1001            mahnoor         |Yogurt=6||| Total = 561.6
14.     August 28,2021          1006            kashmala        |Bread=8|Yogurt=6||| Total = 1138.4
15.     August 28,2021          1010            mahnoor         |Bread=3|Eggs=12|Cake=1||| Total = 1989.1
16.     August 29,2021          1004            drawais         |Eggs=5|Cheese=2||| Total = 846
17.     August 29,2021          1008            kashmala        |Butter=2|Bread=3|Cake=1||| Total = 786.7
18.     August 29,2021          1006            kashmala        |Milk=2|Cheese=4||| Total = 674.4
19.     September 20, 2021      1011            drawais         |Yogurt=2|Bread=1|Eggs=1||| Total = 386.5
```

Meanwhile the CSV file looked like this:



<table>
<tr><th></th><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th><th>F</th><th>G</th></tr>
<tr><td>1</td><td>1</td><td>August 15</td><td>2021</td><td>1001</td><td>drawais</td><td>|Milk=2|Yogurt=1|Eggs=12|</td><td>475.2</td></tr>
<tr><td>2</td><td>2</td><td>August 16</td><td>2021</td><td>1002</td><td>kashmala</td><td>|Cake=1|Butter=2|Eggs=24|Milk=1|</td><td>856.8</td></tr>
<tr><td>3</td><td>3</td><td>August 17</td><td>2021</td><td>1003</td><td>mahnoor</td><td>|Yogurt=2|Milk=1|</td><td>314.4</td></tr>
<tr><td>4</td><td>4</td><td>August 17</td><td>2021</td><td>1004</td><td>drawais</td><td>|Milk=2|Butter=2|Bread=1|</td><td>650.5</td></tr>
<tr><td>5</td><td>5</td><td>August 18</td><td>2021</td><td>1005</td><td>kashmala</td><td>|Butter=1|Cream=1|Cheese=1|Milk=3|</td><td>325</td></tr>
<tr><td>6</td><td>6</td><td>August 18</td><td>2021</td><td>1006</td><td>kashmala</td><td>|Milk=2|Cheese=4|</td><td>674.4</td></tr>
<tr><td>7</td><td>7</td><td>August 23</td><td>2021</td><td>1007</td><td>kashmala</td><td>|Cream=2|Cake=3|</td><td>1135.2</td></tr>
<tr><td>8</td><td>8</td><td>August 24</td><td>2021</td><td>1008</td><td>mahnoor</td><td>|Bread=3|Eggs=3|Cake=7|</td><td>1972.9</td></tr>
<tr><td>9</td><td>9</td><td>August 26</td><td>2021</td><td>1003</td><td>drawais</td><td>|Bread=2|Eggs=2|Cake=4|</td><td>1384.2</td></tr>
<tr><td>10</td><td>10</td><td>August 26</td><td>2021</td><td>1009</td><td>kashmala</td><td>|Eggs=3|Butter=5|</td><td>1072.44</td></tr>
<tr><td>11</td><td>11</td><td>August 27</td><td>2021</td><td>1007</td><td>kashmala</td><td>|Cream=5|Eggs=12|</td><td>2516.4</td></tr>
<tr><td>12</td><td>12</td><td>August 27</td><td>2021</td><td>1006</td><td>kashmala</td><td>|Eggs=3|Butter=6|Milk=6|</td><td>1905.12</td></tr>
<tr><td>13</td><td>13</td><td>August 27</td><td>2021</td><td>1001</td><td>mahnoor</td><td>|Yogurt=6|</td><td>561.6</td></tr>
<tr><td>14</td><td>14</td><td>August 28</td><td>2021</td><td>1006</td><td>kashmala</td><td>|Bread=8|Yogurt=6|</td><td>1138.4</td></tr>
<tr><td>15</td><td>15</td><td>August 28</td><td>2021</td><td>1010</td><td>mahnoor</td><td>|Bread=3|Eggs=12|Cake=1|</td><td>1989.1</td></tr>
<tr><td>16</td><td>16</td><td>August 29</td><td>2021</td><td>1004</td><td>drawais</td><td>|Eggs=5|Cheese=2|</td><td>846</td></tr>
<tr><td>17</td><td>17</td><td>August 29</td><td>2021</td><td>1008</td><td>kashmala</td><td>|Butter=2|Bread=3|Cake=1|</td><td>786.7</td></tr>
<tr><td>18</td><td>18</td><td>August 29</td><td>2021</td><td>1006</td><td>kashmala</td><td>|Milk=2|Cheese=4|</td><td>674.4</td></tr>
<tr><td>19</td><td>19</td><td>September 20</td><td>2021</td><td>1011</td><td>drawais</td><td>|Yogurt=2|Bread=1|Eggs=1|</td><td>386.5</td></tr>
<tr><td>20</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

4. Transition:

After performing the above task, we find the following drawbacks:

- Requirements Completed.
- Can be implemented with Object-Oriented Programming (OOP).

Appendix-B

1. How motivated do you feel to deepen your knowledge about the programming courses?

Weak	Normal	Strong

2. Do you think your programming skills are better than before after taking up this course?

Weak	Normal	Strong

3. Does practical laboratory work help you in understanding the concepts better?

Weak	Normal	Strong

4. Is the expenditure of time for learning to program appropriate?

Weak	Normal	Strong

5. Does the classroom & laboratory atmosphere is friendly and pleasant for learning programming?

Weak	Normal	Strong

6. Do you feel like this is the course field (programming) where you belong?

Weak	Normal	Strong

7. In your opinion, is this approach suitable to teach programming?

Weak	Normal	Strong

8. Is the workload manageable in line with other courses up until now?

Weak	Normal	Strong

9. How do you feel about holding a better professional position in the future after taking up this course?

Weak	Normal	Strong

10. How would you rate your overall experience with the professor after taking this course?

Weak	Normal	Strong