Open Educational Resource (OER): C-Programming Handout based Lab Session using MOODLE for Engineering Education

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Abstract: Open educational resources (OER) are free and openly licensed educational materials. It can be used for teaching, learning, research work and other purposes. OECD (Organization for Economic Co-operation and Development) defines this OER as "digitised materials offered freely and openly for educators, students, and self-learners to use and reuse for teaching, learning, and research. OER includes learning content, software tools to develop, use, and distribute content, and implementation resources such as open licences."
Types of open educational resources include: full courses, course materials, modules, learning objects, open textbooks, openly licensed videos, tests, software, and other tools, materials etc. OER may be freely and openly available static resources and dynamic resources.
We have developed "Open Education Resource (OER): C-Programming Handout based Lab Session using MOODLE". It consists of C-Programming Lab handouts for First Year Engineering students which contains the useful guidelines for implementing the program problem statements in the lab session. Practise problem statements are given in the each handout. Students practise those problem statements in lab session and submit on the MOODLE for assessment purpose. At the end of each lab session, the quiz will conducted on the MOODLE on the topic covered in the lab session. Since this OER is related to the C-Programming, any faculty or students from any stream can use this OER. We are going to use this OER for the students of First Year Engineering Program for C-Programming course in Semester II.

Keywords: Open Educational Resource (OER), C-Programming, handouts, MOODLE (Modular Object-Oriented Dynamic Learning Environment), Wordpress, Think-Pair-Share (TPS), Creative Common Licenses, Bloom's Taxonomy.

1. Introduction

Open educational resources (OER) are freely accessible, openly licensed documents and media. William and Flora Hewlett Foundation define OER as: "Teaching, learning, and research resources that reside in the public domain or have been released under an intellectual property license that permits their free use and re-purposing by others. Open educational resources include full courses, course materials, modules, textbooks, streaming videos, tests, software, and any other tools, materials, or techniques used to support access to knowledge"(https://en.wikipedia.org/wiki/Open_educational_resources). OER may be freely and openly available static resources, dynamic resources which change over time in the course of having knowledge seekers interacting with and updating them or a course or module with a combination of these resources.

Advantages of OER are:

- Access to more quality material
- Helps preparation for course and retention of knowledge even after completion of the course
- More clarity and/or certainty regarding reuse of materials
- Make research available to widest possible audience
- Shares best practice used to improve the teaching process internationally
- Maximizes the use and increases availability of educational materials to students, faculty etc.

Disadvantages of OER are:

- If authors do not update their resources then it can become outdated
- There may be too many restrictions on the resources
- Licensing process may slow down presenting online material

Open Education Resource (OER): C-Programming Handout based Lab Session using MOODLE is collection of C-Programming laboratory practical assignment handouts that are useful as guideline for implementation of C-programs for First Year Engineering students. MOODLE is used to display C-programming course activities, for online submission of the practice problem statements, and to conduct the quiz at the end of each assignment. Wordpress Webpage is used to make C-programming handout available for other peers or instructors to use these handouts

2. Related Work

OER are teaching, learning, and research resources that reside in the public domain or have been released under an intellectual property license that permits their free use or re-purposing by others (Daniel E. Atkins, John Seely Brown, Allen L. Hammond, 2007). Hence the purpose of the Open Educational Resources movement is to provide open access to high quality digital educational materials (Tom Caswell, Shelley Henson, Marion Jensen, David Wiley, 2008).

Dr. Jan Hylén discussed the opportunities and challenges in OER while Li Yuan discussed the background to the current development of and future trends around OER. Wiley (2006) summarised three models for open educational resource projects in higher education: the MIT model, the USU model, and the Rice model. Atkins (2007) has identified a number of approaches to sustainability which should be considered and need to be explored.

Hewlett (2005) describes OpenCourseWare as an initiative in the Open Educational Resources movement while Yue, Yang, Ding, and Chen (2004) discussed the increasing use of OpenCourseWare content for Computer Science education. Downes, Stephen (2007) depicts the sustainability of Open Educational Resources (OERs) in terms of the three models: funding, technical, and content.

Programming language teaching implemented using different strategies like software tools, visualization, debugger, program writing skills etc.

Micaela Esteves et.al. conducted an action research approach to the analysis of how teaching and learning of computer programming at the university level could be developed within the Second Life virtual world.

Samer Al-Imamy and Javanshir Alizadeh proposed, developed, and tested a software tool for teaching a first course in programming languages

Pratibha S. Yalagi et.al. proposed a novice way of teaching C language programming with effective program writing skills for the beginners.

Trupti S. Indi et.al. presented the experiment on how bug fixing skills can be improved using debugger tool Stack Trace for Java Programming.

Manisha Nirgude presented the work about how debugger which helps to improve conceptual understanding of novice learners for C-Programming.

Trupti Indi and Dr. S. A. Halkude proposed the handout based lab practice for Mobile Application Development Course which is "concept – experimental teaching – hands-on practice and assignment based teaching-learning using handouts designed by teacher".

Leen-Kiat Soh et.al. reported on an integrated approach to designing and implementing laboratories with embedded instructional research design.

TPS is a very useful activity which engages the entire class and useful in improving the quantity and quality of student engagement in the class (Aditi Kothiyal et. al. and Sunita M Dol).

Ajlan Al-Ajlan and Hussein Zedan focused on Moodle platform and on a comparison between virtual learning environment (Moodle) and other virtual learning environment systems in order to discover their strengths and limitations. Some analyses and comparisons were made about open source learning management systems and Moodle was outstanding with many features among other LMS that aims to improve the educational quality and include the tools that an e-learning system should have (Aydin Cansu Cigdem and Tirkes Guzin, 2010)

In our OER: C-Programming Handout based Lab Session using MOODLE for Engineering Education, we have included proved strategies such as handout, Moodle, TPS, Debugger and Assessment Strategies like Practice Problem statements and Quiz. Since this course is prerequisite for programming language C++ and Java, this OER will be helpful for engineering students of any stream.

3. Our OER Components and Terms

Fig. 1 shows our OER components and related terms.

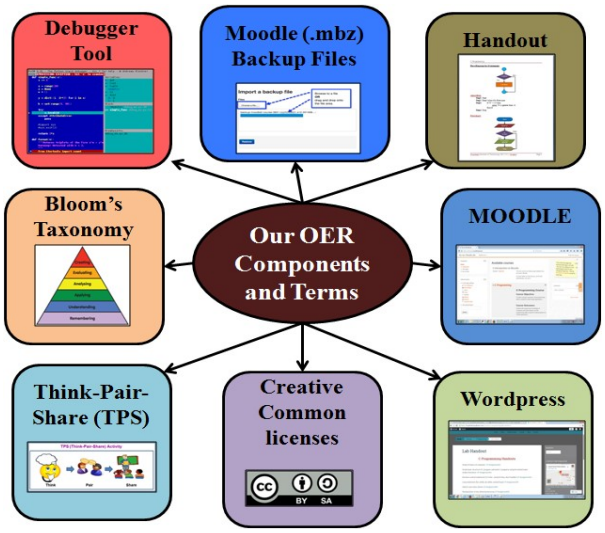


Fig. 1: Our OER Component and Terms

A. Handout

A handout is a paper based resource used to support teaching and learning. It may increase attention and motivation and help students to follow the development of an idea or argument. (http://users.wmin.ac.uk/mcshand/TEACHING/handouts.htm). So it is guided document used by learners which is useful for implementing the problem statements in the lab session.

B. MOODLE (Modular Object-Oriented Dynamic Learning Environment)

Moodle is a free and open-source software learning management system written in PHP. Moodle is used for blended learning, distance education, flipped classroom and other e-learning projects.

C. Wordpress.com

WordPress is web software which you can use to create a beautiful website, blog, or app. WordPress is both free and priceless at the same time. The site for creating webpage is www.wordpress.com.

D. Creative Common Licenses

A Creative Commons (CC) license is one of several public copyright licenses. It enables the free distribution of copyrighted work. A CC license is used when an author wants to give people the right to share, use, and build upon a work that they have created. CC provides author flexibility for example, they might choose to allow only non-commercial uses of their own work and protects the people who use or redistribute an author's work. (https://en.wikipedia.org/wiki/Creative_Commons_license)

E. TPS(Think-Pair-Share) Active Learning Strategy

Think Pair Share shown in Fig. 2 is a well known active learning strategy in which students work on a problem

posed by instructor, first individually (Think), then in pairs (Pair) and finally together with the entire class (Share).
This activity develops soft skills, promotes confidence, self learning & critical thinking ability.
Fig. 3 shows the activity performed by instructor and students in TPS activity

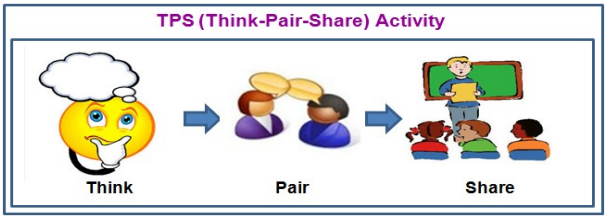


Fig. 2: TPS Activity

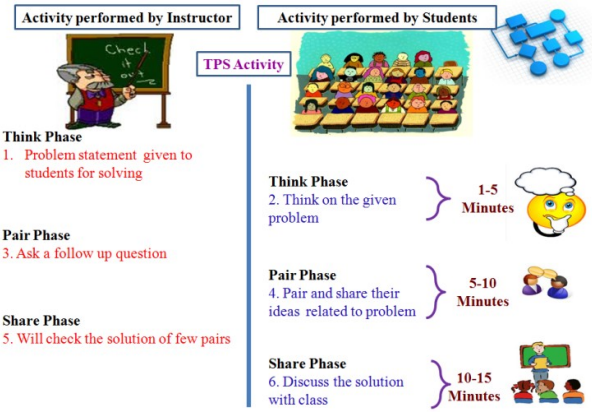


Fig. 3: Activity performed by instructor and students in TPS activity

1. TPS for Programming problem statement
For programming problem statements, TPS activity can be conducted in the following way
Think Phase: Write the algorithm or pseudo code for the given problem statement
Pair Phase: Write the program using C programming syntax and execute. Students will implement the program individually and in pair resolve the errors occurred during execution of program. Here pair programming concept is used.
Share Phase: Students share the different solution of the given problem statement.
e.g. Write a C program to fine the smallest number of the array

- Think: Write the pseudo code or algorithm to fine the smallest number of the array.
- Pair: Discuss your answer with your neighbor, do pros and cons analysis of your algorithms. Students will write the program individually on the computer but help each other to complete that program.
- Share: Participate in discussion of your solution and others.

F. Bloom's Taxonomy
Bloom's taxonomy is a set of three hierarchical models used to classify educational learning objectives into levels of complexity and mastery.

There are three domains: cognitive, affective and psychomotor
domains. (https://en.wikipedia.org/wiki/Bloom%27s_taxonomy)
The cognitive domain is frequently used to structure curriculum learning objectives, assessments and activities. Cognitive levels of Bloom's Taxonomy are shown in Fig. 4. All questions considered in the quiz covers recall, understand and apply level of cognitive domain of Bloom's Taxonomy.

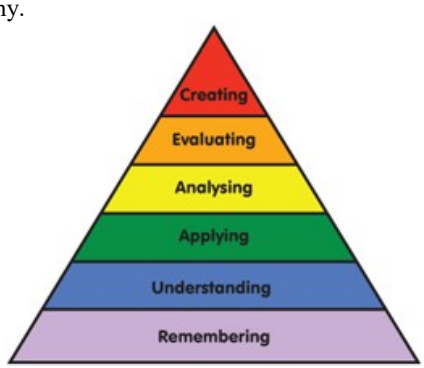


Fig. 4: Bloom's Taxonomy levels

G. Debugger Tool
Debugger is a computer program that is used to test and debug the execution of a program. Debugger is used for testing, pointing out errors in written program and understanding the flow of execution. It is possible to check step by step execution, changed values of variables or memory locations.

H. Moodle (.mbz) Backup Files
A Moodle Backup FIle (.mbz) is a compressed archive of a Moodle course which can be used to restore a course within Moodle. The file preserves course contents, structure and settings, but does not include student work or grades. Moodle backup files include: Resources, Activities and Settings. It does not include the students' enrolment, groups, guest access setting and contribution to the collaborative activity made by course member (https://www.umass.edu/it/support/moodle/moodle-mbz-backup-files).

4. About OER-
Open Education Resource (OER): C-Programming Handout based Lab Session using MOODLE is collection of C-Programming lab handouts useful as guideline for implementation of C-programs for First Year Engineering students. Handout is guided document for learner which is useful across domains. We have designed handout for C-programming lab assignment which will guide the students for designing and implementing the C-program in lab session.
MOODLE is used to display C-programming course activities, for online submission of the practice problem statements, and to conduct the quiz at the end of each assignment. Wordpress Webpage is used to make C-programming handout available for other peers or instructors to use these handouts. To use this OER, basic knowledge of how to use MOODLE is required

- OER is downloadable from: https://sunitadolwit.wordpress.com/study-material/c-programming-2/lab-handouts/ OR https://truptiindi.wordpress.com/courses/c-programming/lab-handout/
- Target Audience: First year Engineering Students (any domain)
- Tags:
  - C Programming,
  - Handout,
  - MOODLE,
  - Think-Pair-Share,
  - Educational Technology,
  - Engineering Students
- OER developed is used through MOODLE CLOUD
- This resource is licensed under CC-BY-SA ver 4.0. You are free to use, distribute and modify it, including for commercial purposes, provided you acknowledge the source and share-alike. To see more details about the license visit http://creativecommons.org/licenses/by-sa/4.0/

A. Learning Objectives

After using this OER, learner will be able to:

- Explain the basic concepts of C-programming.
- Write an algorithm for the given problem statement.
- Draw the flowchart for the given problem statement.
- Design and implement the C program using basic concept of C-programming such as decision making statement, loop constructs, arrays, functions etc.

5. OER Description

A. Lab Handouts

Handout is guided document useful for learners during non-contact hours of instructor such as during the lab session or out of class. In our OER, we have designed handout for C-programming lab assignment. Each handout consists of - problem statement, learning objectives, concept, flowchart, algorithm, program, input, output, practice problem statement, learning outcomes and conclusion.

1. Lab Handout Template

Following points shown in Fig. 5 are covered while designing the C-Programming handout:

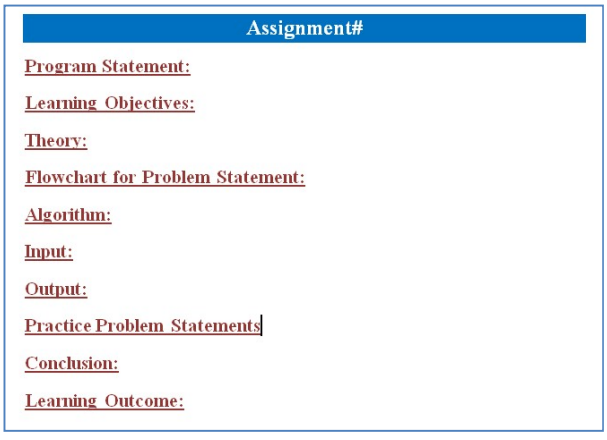
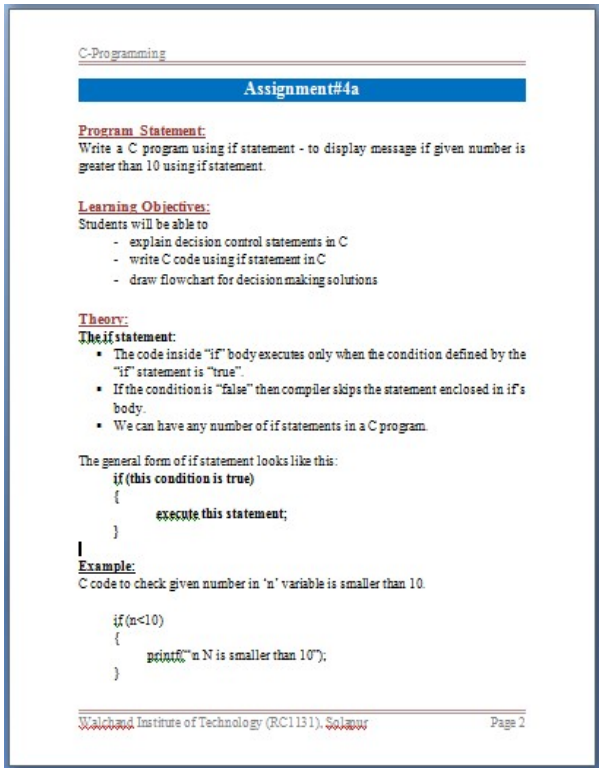
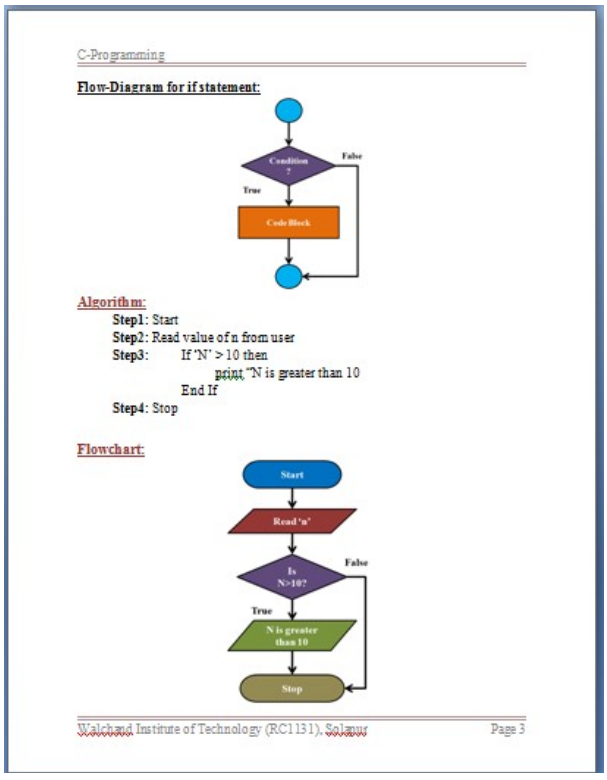


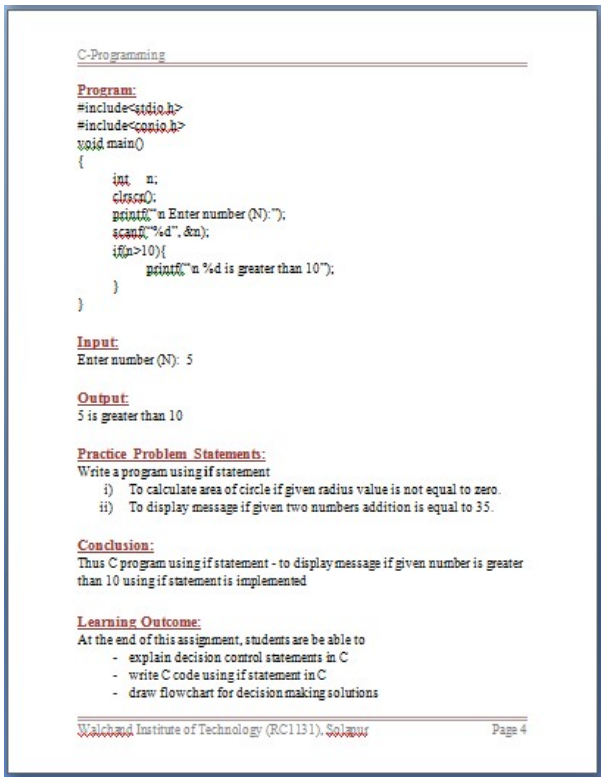
Fig. 5: Handout Template

2. Lab Handout Example

Lab handout example for one of the assignment of C-Programming course is shown in the following Fig. 6.







C-Programming

Program:

```
#include<stdio.h>
#include<conio.h>
void main()
{
    int  n;
    clrscr();
    printf("\n Enter number (N):");
    scanf("%d", &n);
    if(n>10){
        printf("\n %d is greater than 10");
    }
}
```

Input:
Enter number (N): 5

Output:
5 is greater than 10

Practice Problem Statements:
Write a program using if statement
i) To calculate area of circle if given radius value is not equal to zero.
ii) To display message if given two numbers addition is equal to 35.

Conclusion:
Thus C program using if statement - to display message if given number is greater than 10 using if statement is implemented

Learning Outcome:
At the end of this assignment, students are be able to
- explain decision control statements in C
- write C code using if statement in C
- draw flowchart for decision making solutions

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Fig. 6: Handout Example

B. Wordpress

C-Programming lab handouts and moodle backup file (.mbz file) are also made available on the following faculty webpage shown in Fig. 7:
https://sunitadolwit.wordpress.com/study-material/c-programming-2/lab-handouts/ OR
https://truptiindi.wordpress.com/courses/c-programming/lab-handout/

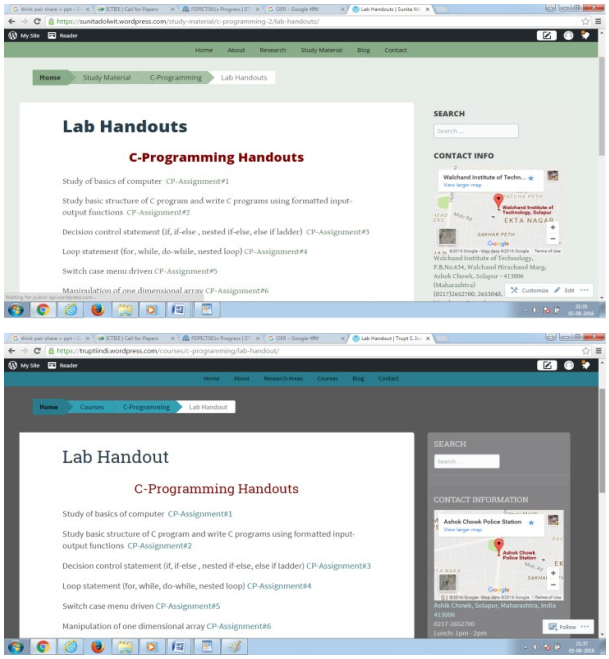

Fig. 7: Wordpress Webpage

C. Active OER

For checking the active OER, you may access the Guest Course for C-Programming – (https://wititsurindia.moodlecloud.com/login/index.php)
[Note: Use Firefox or Internet Explorer for opening the MOODLE CLOUD]
The guest username required for exploring the activity is: guest1
The guest password required for exploring the activity is: guest@123
C-programming handouts are uploaded on the following webpage:
https://sunitadolwit.wordpress.com/study-material/c-programming-2/lab-handouts/ OR
https://truptiindi.wordpress.com/courses/c-programming/lab-handout/

D. How to setup OER at Instructor Level

Method 1:
For using this OER, following are the steps which are shown in Fig. 20:
Step 1: Download C-Programming handout in each lab session from the faculty webpage.
Step 2: Go to the MOODLE course where you want to create this course.
Step 3: Follow the steps as given in snapshot to create course and to use this OER.
Step 4: Enrol students for this course
Step 5: Week wise make these assignments and handouts available for students.
Step 6: Follow assessment strategy for each assignment as mentioned and complete it on MOODLE.
The handouts will be uploaded week wise to MOODLE as per the lab sessions and assignments.

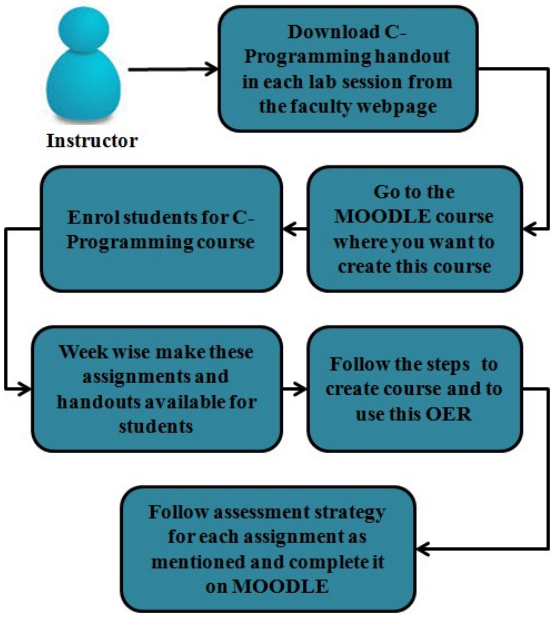

Fig. 20: How to set up OER at Instructor level using method 1

Method 2:
For using this OER, please ensure that you have admin permission in your MOODLE course else asks your administrator to restore this backup in your course.
Step 1: Download the MOODLE backup file (.mbz) from Webpage Link for Handout

https://sunitadolwit.wordpress.com/study-material/c-programming-2/lab-handouts/
OR
https://truptiindi.wordpress.com/courses/c-programming/lab-handout/

Webpage link for Moodle Backup Files

https://sunitadolwit.wordpress.com/study-material/c-programming-2/moodle-back-up-file-mbz/
OR
https://truptiindi.wordpress.com/courses/c-programming/moodle-backup-files-mbz/

Step 2: Go to the MOODLE course where you want to import this lesson. In the Administration section click "Restore"
Step 3: Drag and drop the files into the "Files" area and click restore
Step 4: Verify the contents of the restore by going back to the course. Here, the instructor can modify the course setting and quiz setting as per his requirements.
Step 5: After verifying, post the instructions to your students to complete the lesson activity before the next class using MOODLE forums.
Step 6: Before start of the next class please go and check the reports to see how students performed.
These steps are shown in Fig. 21.

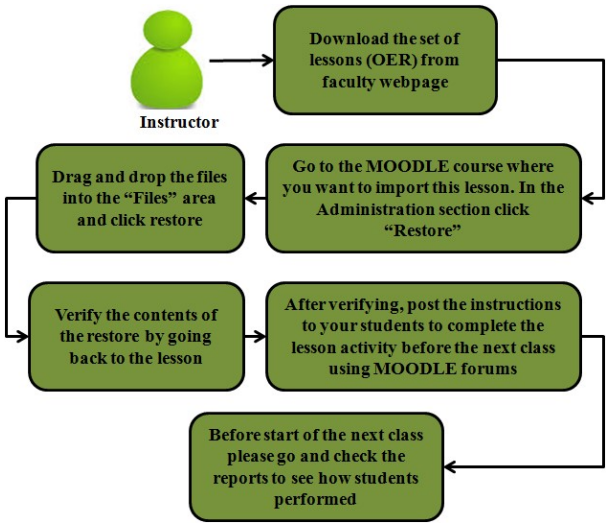

Fig. 21: How to set up OER at Instructor level using method 2

E. How to use OER at Students Level
How to use OER at student's level is shown in Fig. 22. First student log into the MOODLE and enrolled for C-Programming. Then he will go through the handout of the particular session. Students will write and execute the given problem statement in the handout. After that students write and execute the first practise problem statement using TPS mentioned above and complete the remaining practice problem statement individually. Students will submit the given problem statement and the practise problem statement on the MOODLE submission link. In the last 10 minutes, students will attempt the quiz and logout the MOODLE. This OER is designed for lab session and lab session is of 2 hours that is 120 minutes.

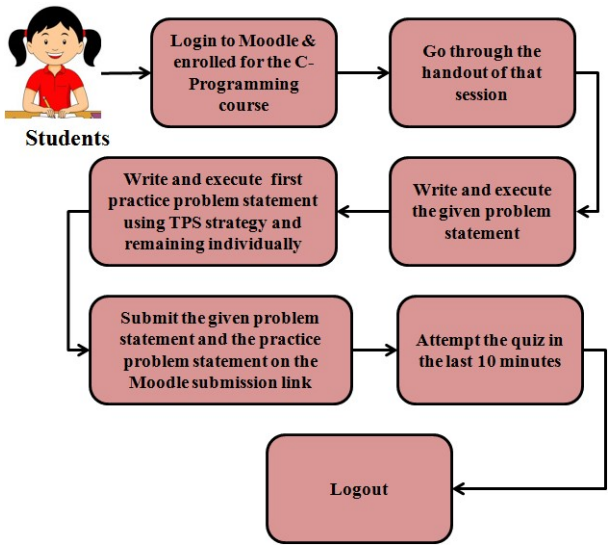

Fig. 22: How to set up OER at students level

F. Assessment Strategy using Moodle
1. Practice Problem Statement Submission
In every lab session, practise problem statement will be given to the students related to the topic considered in the lab session. Cognitive Levels of practice problem statement given in lab session along with the resources – Mostly Recall to Create level of Cognitive level of Bloom's Taxonomy.

2. Quiz
In last 10 minutes, the quiz related to the topic covered in the lab session for the problem statement will be conducted. Cognitive Levels of Quiz conducted on MOODLE covers mostly Recall to Apply level question of Cognitive level of Bloom's Taxonomy.

G. Best Practices with C-Programming Handouts
Here are some of the best practices from our experience on using these handouts in classroom:

- Provide the handout during the lab session.
- Provide minor incentive (marks) for completion of given practice problem statement.
- Ensure that students are following the guidelines and examples provided in the handout and implementing the same. Also make sure that students are completing the practice statement in the lab.

It would be good if the handout is available separately under "Resources" folder in the MOODLE along with other

material if provided. Quiz will be visible only in the last 15 minutes of the lab session to attempt

6. Evaluating Effectiveness of OER

A. OER effectiveness

The OER effectiveness can be assessed at two levels:

1. At the student level
2. At the consumer level

1. Effectiveness at the student level

Effectiveness at the student level involves metrics related to student access of the resource and student learning.

The Moodle report can be used to evaluate this effectiveness, with the report showing the total number of students who accessed the handout (along with time) and their marks (based on their answers to MCQs). Additionally there is an option for teacher to grade essays and these marks also will be calculated if needed.

2. Effectiveness at consumer level

OER consumers are typically teachers who want their students to learn C-Programming. Linking a survey can help in identifying the effectiveness of this OER at consumer level. This has to be done as a follow-up activity.

B. Implementing Survey

Thus every user who downloads this resource will provide their email address and as a follow up the survey will be sending to their email address.

C. Survey Questionnaire

Table1: Survey Questionnaire

Construct	Question	Scale
Ease of use	I found it easy to download	Strongly Disagree to Strongly Agree (5-point Likert Scale)
	I found the instructions to conduct the lab assignment useful for C-Programming	
	I was able to successfully create lab activity in my own course.	
	Debugger Tool help me to test, point out errors in written program and understand the flow of execution	
Concept Coverage	The handout covers the required concepts related to C-Programming that I need for my course	
	The handout covers the basics required for programming like flowchart, algorithm etc.	
Concept Complexity	The topics in C-Programming is too complex for my students to understand	

7. Building a Community of Moodle and Handout based Learning

A. Possible Sources for Community Building

Some of the viable sources for building a community are:

- Teachers who are using MOODLE
- Teachers who plan to use handout for programming courses in lab-session

B. Plans for Community Building

The resource is already available in the https://sunitadolwit.wordpress.com/study-material/c-programming-2/lab-handouts/ https://truptiindi.wordpress.com/courses/c-programming/lab-handout/ and consumer will provide their email address when visited to the Wordpress webpage provided. Thus there will be a list of interested users whom we can follow up using email. All the interested users can then be connected using a local Wordpress or Moodle website.

8. Conclusions

Open Educational Resources (OER) are teaching and learning materials which are freely available online for everyone e.g. instructor, students, or self-learner to use. We have developed Open Education Resource (OER) for C-Programming of First Year Engineering students. C-Programming language is the base for all programming language; hence this language is very important from students' point of view. The C-Programming course is common to all first year engineering students of any stream. The OER developed for C-Programming will be useful for students and instructor of any stream.

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