A Model for Teaching and Evaluation of Programming Courses in Online mode

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Abstract:

To protect community health in the face of the recent spread of COVID-19 epidemic, the world has shifted towards online education. Academics must handle the difficulties presented by the switch from conventional to online learning to preserve the learning process and guarantee that all learning goals are met. One of the key components of engineering education that is significantly impacted using online learning is practical experience. Due to the university's closing and the need for social distance in covid era, students were not able to access physical laboratories. In the present post-covid times, with the rising interest in online courses for skill enhancement and personal growth, institutions and ed-tech companies offering practical courses are finding it difficult to impart programming subjects to students. Another equally important aspect is the choice of right assessment technique for assessing the skill set acquired during the course. This paper proposes a model for conducting lab sessions for practical courses of computer programming, and assessment structure through which coding efficiency of a student can be judged.

Keywords: Online Programming Courses, E- Learning, Assessment Tools

1. INTRODUCTION

Online education, also known as e-learning or virtual learning, refers to the process of acquiring knowledge, skills, or education through the internet and digital technologies. It involves the delivery of educational content, instruction, and interaction between students and teachers or peers over online platforms. Online education can take various forms, including:

A. *Online Courses*: These are structured educational programs offered entirely or partially online. They can range from short, single-topic courses to full degree programs [1].

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C. *Virtual Classrooms*: Online education often includes live virtual classrooms where instructors and students interact in real-time through video conferencing tools, chat, or discussion forums.

D. *Webinars and Workshops*: These are typically one-time or short-duration events conducted online, focusing on specific topics or skills [2].

E. *Massive Open Online Courses (MOOCs)*: These are large-scale online courses designed to accommodate a large number of participants. They often provide free access to course materials, though certificates or credentials may require payment.

F. *Blended Learning*: In some cases, online education is combined with traditional in- person learning, creating a hybrid or blended learning model.
G. *Self-paced Learning*: Some online courses allow students to learn at their own pace, completing modules or assignments as their schedules permit.

2. TEACHING AND EVALUATION OF PROGRAMMING COURSES IN ONLINE MODE

The mode of teaching and learning programming courses online had evolved significantly due to advancements in technology and educational methods. It has also received a significant thrust due to recent covid-19 pandemic [3]. Though the teaching pedagogy, which in this case is heavily influenced and dependent on technology, has witnessed a consistent change in recent years. We may witness many more changes related to Artificial Intelligence inculcated in online education as this paper is being developed and discussed. During past few years following modes of imparting online programming courses have gained popularity. Following is a brief discussion on methods of imparting programming courses online.

Interactive Online Courses: Many online platforms and universities offered interactive programming courses where students could watch video lectures, complete coding exercises, and receive immediate feedback[4]. These courses often provide a structured curriculum and allow students to learn at their own pace [5].

A. *Massive Open Online Courses (MOOCs):* MOOC platforms like Coursera, edX, and Udacity continued to offer a wide range of programming courses and degrees. These platforms often partner with top universities and institutions to provide high-quality content [6].

B. *Coding Bootcamps*: Online coding bootcamps became popular for intensive, short-term coding education. These programs are designed to quickly teach students practical coding skills and often include hands-on projects and career support.

C. *Live Virtual Classes*: Many online courses and bootcamps started offering live, instructor-led virtual classes through video conferencing platforms. This approach allows for real-time interaction with instructors and peers.

D. *Project-Based Learning*: A focus on project- based learning became more prominent. Online learners were encouraged to work on real-world projects to apply their programming skills and build a portfolio[7].

E. *Peer Collaboration*: Online platforms increasingly encouraged peer collaboration through discussion forums, coding challenges, and group projects. Collaborative learning can help students learn from one another[8].

F. *Gamification and Interactive Learning*: Some online courses incorporated gamification elements, quizzes, and interactive coding challenges to make learning more engaging and enjoyable.

G. *Self-Paced Learning*: Online platforms continued to offer self-paced learning options, allowing students to start and finish courses on their own schedules[9].

H. *Instructor Feedback and Support*: Many online courses provided mechanisms for students to seek help from instructors or teaching assistants, whether through office hours, forums, or messaging systems.

I. *Certifications and Credentials*: Online platforms and institutions offered certifications and credentials upon course completion, helping learners showcase their skills to potential employers.

J. *Programming Environments*: Online programming courses frequently integrated coding environments that allowed students to write and test code directly within their web browsers.

It's important to note that the mode of teaching programming online can vary significantly depending on the platform, the course, and the target audience. Moreover, the field of online education continues to evolve, so there may have been additional innovations and changes in the approach to teaching programming online since my last update. To get the most current information, you should explore the latest offerings from online education providers and institutions.

3. LIMITATIONS OF LEARNING PROGRAMMING COURSES VIA ONLINE MODE

Online education offers several advantages, including flexibility in terms of when and where you can learn, access to a wide range of courses and programs, and the ability to tailor your learning experience to your individual needs[10]. It has become increasingly popular, especially in recent years, and is used for various purposes, from formal education to professional development and skill enhancement[11]. However, successful online learning often requires self-discipline, time management, and strong digital literacy skills. Learning programming subjects online can be highly effective and convenient, but it also has some limitations[12], [13]. Here are several limitations to consider:[14]

1. Lack of Hands-On Experience: Programming often requires practical, hands-on experience. While online courses can provide theoretical knowledge, they may not offer as many opportunities for practical coding exercises and real-world projects compared to in- person classes or workshops.

2. Limited Access to Instructors: In online courses, your access to instructors or tutors may be limited. Getting immediate help or clarification on complex topics can be more challenging when compared to in-person classes.

3. Isolation and Lack of Social Interaction: Learning online can be isolating, as you may not have the same level of social interaction with peers and instructors as you would in a physical classroom. Collaboration and team work which forms core of software development is largely compromised.

4. Self-Discipline and Motivation: Online learning often requires a higher level of self- discipline and motivation. Without the structure of a physical classroom and face-to- face accountability, some learners may struggle to stay on track.

5. Limited Access to Labs and Resources: Some programming subjects may require access to specialized labs, equipment, or software that may not be readily available online. This limitation can be a barrier to hands-on learning.

6. Limited Networking Opportunities: Building professional relationships and networking can be more challenging in an online learning environment, which may affect your career opportunities.
Authors also accept and acknowledge that despite these limitations, many individuals have successfully learned programming and related subjects online. To overcome the above-mentioned challenges, it's essential to choose reputable online courses, establish a structured learning routine, seek out additional resources, and actively engage with online communities and forums to connect with peers and instructors. Additionally, blending online learning with hands-on practice and seeking out in-person workshops or coding meetups can help mitigate some of these limitations.

4. PROPOSED MODEL OF TEACHING PROGRAMMING COURSES IN ONLINE MODE

The need of programming courses in online mode arises in following cases.
- As part of standard university curriculum where a course bears credits which are essential component for eligibility to gain a degree or diploma. Here course is to be completed in a fixed number of sessions and evaluation is done based on assignments submitted online and periodic quizzes conducted at the end of each module. In a university pattern, sometimes a viva is also conducted via online video conferencing platform to judge the skills of participant.
- As a short-term course or internship for personal skill development where a candidate enrolls in a short-term course or paid-internship with a company and learns the technology aspects from

the industry experts. In this scenario, the trainer or team lead imparts a few basic skills to the interns and helps them to directly work on a live project under his supervision. The progression of candidate is assessed by his growth in performance-based assessment.[14]

- As a certification course from technology provider used for targeted career segment and workforce development for industry. In this mode a candidate is studying to learn a technology in a targeted manner where education division of technology provider provides content and cloud access to the candidate to study. After completion candidate must pass an exam conducted online by the technology provider, like Oracle, Microsoft, Cisco, IBM etc, and is awarded with a certification.

A. *Need of the model*: It is often observed that an important component of learning programming i.e. peer-study or team work, is completely or partially ignored in almost all the above mentioned cases. Technocrats, educationists, and researchers have repeatedly mentioned that a peer-group study is essential for learning programming. Programming involves debugging of code where help is often sought and received enhancing the skills of the coder. Collaborative learning is a part of knowledge journey[15]. Computer science students often take keen interest in online communities where coding problems are posted and solutions are discussed. Active involvement in tech-communities on public portals and private chat-rooms demonstrates the skills of a programmer. It is also to be recorded that almost all online courses follow different pattern or pedagogy of imparting practical education. In the absence of a standardized approach it is sometimes unfair to compare performance or grading pattern of courses from different platforms.

B. *Objective:* This paper intends to propose an effective model for teaching and evaluating programming courses via online mode. It requires careful planning and consideration of various elements.

C. *Methodology*: For the development of model, authors discussed the need and objective with a group of academicians and students and recorded their opinions. These opinions are treated as views of experts and were considered as base or foundation for developing the model. An in-depth study was performed while studying the work done previously by researchers in area of e- learning and technology enabled learning. After preparation of the first draft of the proposed model, it was presented before a group of distinguished teachers and their opinion was duly noted for further improvement and the final draft of the model was prepared. [1]

Figure 1 demonstrates a model that authors propose to impart teaching and assessment of programming subjects for students of computer science:
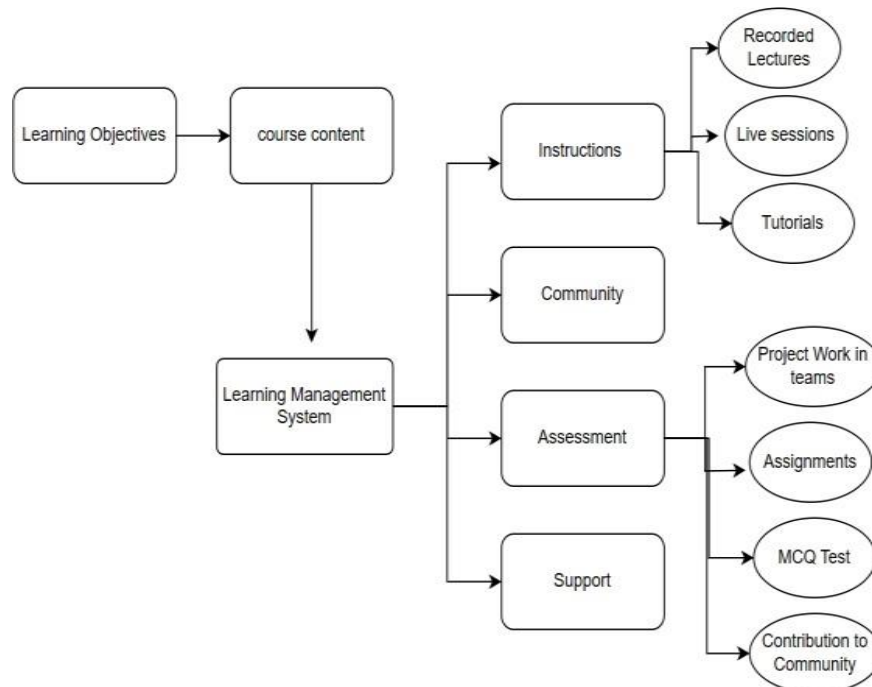
Figure 1: Proposed Model for teaching and evaluation of computer programming in online mode

The arrows in the diagram represent the flow of information between the different components of the model. For example, the learning objectives lays the path for the development of the course content, and the assessment lays the guidelines for various components of final assessment of students. The different components of the model can be implemented in different ways, depending on the specific needs of the course and the students. However, the diagram provides a general overview of the key elements that should be considered when teaching and evaluating programming subjects via online mode.

Here is a brief explanation of each component of the diagram:
- Learning Objectives: These are the skills and knowledge that students should acquire by the end of the course.
- Course Content: This includes the lectures, readings, exercises, and projects that will be used to teach the students the skills and knowledge they need.
- Learning Management System (LMS): This is a software platform that can be used to deliver online courses. It provides a way for students to access the course content, communicate with the instructor, and submit assignments.
- Instruction: This is the process of teaching the students the skills and knowledge they need. It can be delivered through a variety of methods, such as lectures, demonstrations, and hands-on exercises.
- Assessment: This is the process of measuring students' mastery of the learning objectives. It can be done through quizzes, MCQ based online test, project work, assignments followed by viva, and contribution to community.
- Support: This is the help and assistance that is provided to students throughout the course. It can include things like online forums, email support, and office hours.
- Community: This is the sense of belonging and connection that is created among students. It can be fostered through online forums, chat rooms, or social media groups.

D. Assessment Scheme
Following are the proposed components for the assessment of programming and practical courses in

online mode:

- Quizzes – to be conducted at the end of every module in online mode. It can bear a minimal weightage or can simply be attempted to pursue next module.
- MCQ based online test- to be conducted at the end of each module. It bears marks weightage or can be graded as per the performance of the candidate.
- Assignments submission- every course must include assignments which bear practical questions whose solutions can be uploaded using LMS and are to be evaluated by the course trainer. Services of some online coding platforms can be used to assign and evaluate questions of assignments.
- Project work completed in team- every candidate must work in a project and perform the task assigned to the team. Every completed project may be evaluated for the grade score of each candidate. Evaluation of project can be done using an online viva.
- Contribution to community- every student must contribute to the online communities of the same domain using institution provided platform of on a public platform where a jump in 5 rank points can be treated as a benchmark for a minimum eligibility. Alternatively, many platforms use concepts of comment endorsements or citations of the replies which can be taken as a contributing factor for grading. [1]

A brief representation of the above content is provided as Table 1 below:

Table 1: weightage assigned to assessment tools

Tools	Grade d	Periodicity	Weightage
Quizzes	Yes/N o	After every tutorial/lecture	10%
MCQ based test	Yes	After every module	20%
Assignment s	Yes	After complete course	30%
Project Work with viva	Yes	Once every course	30%
Contribution to community	Yes	More than 5 contributions during course	10% - 20%

The above classification of students' contribution towards online communities is taken as a preliminary step for preparing a candidate to work in team and enhance his/her knowledge by sharing of information witht eh peer group. Authors understand that not every institution provides a vast infrastructure or portals for students knowledge sharing blogs, and hence propose to use public platforms available for the purpose. Many existing competitive coding platforms provide ranking system for their contributors and content providers. A candidate can be marked or graded based on improvement in atleast 5 ranking points, or when his contribution or solution is endorsed or cited by another user. Authors believe it to be a principal factor where knowledge of the candidate can be judged by his peer group and hence can act as a motivating factor for every candidate while working online.

5. CONCLUSION

Academia has accepted online education as an essential part for upskilling and upgrading knowledge. Many courses including programming courses are considered difficult to teach and assess in online mode. The proposed model in this paper has considered several aspects of teaching in online mode. A specific focus is set on assessment of programming skills of candidates which include online quiz, assignments, project work, viva and contribution to online communities. The proposed model and methodology of assessment is further presented for reviews and comments. Limitations related to technical infrastructure, acceptance of third-party portals and communities and developing tradition of team-work in online-mode are duly noted and present itself as a research area for future.

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