Development and Evaluation of E-Learning Courses: Validity, Practicality, and Effectiveness

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Abstract—This study attempts to develop a reliable, practical, and efficient process for developing online and distance courses. The study aims to develop e-learning online and distance education courses. ICT and e-Research course development processes have shown significant learning opportunities and outcomes. A substitute for raising these opportunities is the need for innovative research in education while implementing online and distance modes of learning and teaching. Subscribing research and development research methodology, the study aims to produce e-learning instructional materials using a three-stage development model. The course, along with the learning strategy, the learning tools, the assessment tools, and other components, are designed and developed using the Plomp model, a development research model. The research participants were forty-two 2021 Winter Batch MPhil in Educational Studies students and nine lecturers at Nepal Open University (NOU), Nepal. The descriptive analysis uses data analysis to explain the online course's validity, applicability, and effectiveness. Experimental research design was developed using the one-group pre-test post-test design methodology. The most important results are results of preliminary analysis, validity: average material validation is 0.885; average media validation is 0.885 and practicality: more than 71% (very practical). This article proposes a more comprehensive framework to design, develop, and implement online and distance courses in e-learning systems in higher education.

Keywords—ICT and e-research, innovation in education, designed and developed, e-learning, modules, Plomp model, descriptive analysis

1 Introduction

In the digital era, science and technology development is gaining momentum [10-12]. This momentum offered ample opportunities in science and technology and educational technologies (to name but a few). When it comes to educational technologies to enhance teaching and learning, educational technologies are the field of study that looks into the process of analyzing, designing, developing, implementing, and evaluating the instructional environment, learning materials, students, and the learning process

[32]. Likewise, the role of educational technology in education is crucial because it enables teachers to incorporate new tools and technologies into their classrooms and learners to grab the knowledge at their pace, speed, and time [19]. However, learning is not limited to solo teaching and learning processes but can be extended beyond classroom boundaries [17]. The learning is accomplished in synchronous and/or asynchronous ways [11]. In these ways of learning, developing e-learning courses is always challenging and difficult for faculty members in the universities [20]. Universities in Nepal are developing different frameworks for designing e-learning courses by engaging the course facilitators in framing self-learning materials [20]. With this ethos, the course ICT and e-Research is taken for this study from one of the MPhil courses offering soon in one of the universities in Nepal. The problems that occur in learning ICT and e-Research include technical issues, limited connectivity, lack of interaction, online distractions, disabilities, special needs, and poor digital literacy [13]. In addition, it is difficult to explain the phenomena of various subsystems directly; students lose interest; as a result, a low success rate and continuous feedback as a participatory pedagogy throughout the learning process might help the learners succeed. Face-to-face sessions are limited for teachers, but there are more opportunities for students.

Using projects, problem-based learning, and interactive learning models can resolve the issues mentioned above [24]. Along with module-based learning, integrating modules and media as teaching aids enhances student learning. E-learning programs make it simple for students to study material at home and use it as a resource for course modules.

Creating a digital learning module with images, animations, texts, and videos can assist students in visualizing the material. The behavioristic, cognitive, and constructivist perspectives serve as the theoretical underpinning for creating learning modules for online instructions in online and distance modes [21, 33]. The three learning theories—behavioristic, cognitive, and constructivist-- inform ICT-based education. Behavioristic (about facts), cognitive (about principles and procedures), or constructivist learning can be categorized (about higher-order thinking and context). For successful learning, both intrinsic and extrinsic motivation must exist to comprehend and explain behavior. Students must use learning materials to achieve objectives and participate in learning. As teaching aids, one can utilize books, handouts, audio files and other materials.

Students may utilize the module individually or in groups without a course facilitator(s). Butcher et al. suggested some of the benefits of the module: 1) It can make the message presentation clearer and less verbose; 2) It can help students and lecturers overcome limitations on time, space, and sensory capacity; 3) It may increase eagerness and motivation to learn; 4) It can support students in gaining the skills necessary to engage directly with the outside world and other resources; 5) Electronic devices can be used by students to access the course materials, and e-modules are more effective than traditional textbooks for instruction; (6) They must evaluate or measure their learning outcomes [9]. Similarly, current modules can be manufactured electronically (e-modules) [5]. Above all, developing a reliable, practical, and efficient process for developing online and distance courses is a need of the 21st century. This study's overarching goal was to design an e-learning course and its modules for the course ICT and

e-Research, which is focused on the design, creation, and implementation of online and distance learning programs in higher education [25].

2 Literature review

What we call "courseware" is just a portmanteau of "course" and "software". The term refers to a type of software that includes educational materials and methods of teaching. Documents, videos, PDFs, audio files, images, quizzes, and surveys are examples of what could be included in such a package. In this line [22] stated:

Courseware development concerns the design and development of appropriate electronic materials for teaching and learning. This includes using authoring tools and scripting languages to develop multimedia educational materials, including databases, file systems, and website development. The Courseware Developer works with an instructional designer, subject matter experts, and graphic designer to ensure quality and accurate development and implementation of design and final products (teaching and learning material). The Developer provides advice on aspects of technology, best practices, and courseware development and administers project coordination and consultations concerning appropriate electronic materials for teaching and learning. (p. 1)

In developing the courseware, standard procedures for creating instructional software are generally followed by analysis, design, development, implementation, and evaluation.

See Figure 1.

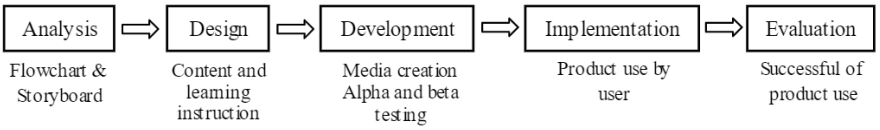

Fig. 1. Generic educational courseware development process (Source: [18, p. 118])

In addition, Zulkifli et al. present the ROSE model of courseware, a tailored educational resource created to address gaps in the Malaysian primary school road safety education curriculum [34]. Blending virtual reality (VR), augmented reality (AR), and interactive multimedia into a single learning environment provides young people with a dynamic, real-time, and immersive resource for learning about and practicing road safety. For enhancing student learning outcomes and motivation, Krismadinata et al. researched creating an e-learning courseware module for a power electronics course that would be valid, practical, and effective [21]. The course materials were adapted by AM et al. to be more accessible to students who traditionally struggle in the classroom; the study explained how signaling principles were applied to the development of courseware for low-achieving students as part of the study [3]. The prototyping process was oriented around the needs of the end user. It was created with input from its end users. After that, it was distributed to end-users. Their interactions with the prototype were observed in real time by their teachers. According to research by Marta et al. on

the development of e-learning and fundamental network modules; students perform best when provided with a multimedia-based module that includes distinct learning objectives; a timeline for achieving those objectives; a summary of relevant materials, and practice tests that can be used to evaluate their progress [23]. Classroom-based multimedia lesson plan to enhance students' learning during regularly scheduled class time. This multimedia-based learning module allows for convenient content review (self-learning) anytime, anywhere.

The above considerations and studies by [22, 18, 34, 21, 3, 23] showcase the need for the suggest the ongoing development of the courseware development for the learners to learn in their own pace, speed, and time. In the case of course ICT and e-Research in this study, it attempts in developing a reliable, practical, and efficient processes.

3 Research and development research methodology

Subscribing research and development (R&D) research methodology aims to produce reliable, practical, and efficient e-learning instructional materials [14, 29] for the ICT and e-Research. Research and development research methodology for the study of education is crucial because it ensures that the techniques used to study educational issues and topics are valid, effective, and reliable, and that the conclusions drawn from educational research are reliable and useful [6-7]. Within R&D research methodology, we have chosen R&D research methodology using a three-stage development model [8, 21, 27, 28]. The first stage of preliminary research is the analysis of the course outline, the concept, and the pace of the learners. The second stage is the design prototype phases, including prototypes 1 and 2 and their design, development and implementation. The third stage is the evaluation phase. The phases of implementing modules development in the Plomp model [27, 28] are discussed as follows:

3.1 Stage 1

Analysis. The analysis phase involves steps like "needs analysis," "problem identification," and "task analysis," all of which define the learning objectives. Because of this, the deliverables we produce will include profiles of potential students and lecturers, a list of gaps, a list of needs, and a detailed task analysis based on these needs.

3.2 Stage 2

Design. Essentially, design is a methodical procedure for accomplishing the desired result. At this point, we work to develop SMART (specific, measurable, attainable, and relevant) goals for our designing and implementing. This is where we conduct our tests as well. The learning strategy, learning media, and learning resources can then be determined based on the test results [8], which are based on the formulated learning objectives. An accurate and comprehensive plan is crucial. The experimental research design was developed, and the Likert scale questionnaire was used to gather data on the applicability of the course based on the responses by students and lecturers.

Development. Development is the process of realizing the blueprint has come true. An important step in the development phase is a trial before it is implemented. This trial phase is part of one of the Plomp models [27, 28]. More precisely, formative evaluation because the results are used to improve the facilitating process and learning being developed. Before the final course is tested and validated by the validators and/or experts.

Implementation. Implementation is crucial in putting the learning system we are creating into action. At this point, everything has been created or configured in accordance with its intended use. This step's primary goals are to 1) help students achieve goals or competencies, 2) ensure that problem-solving occurs, and 3) make sure that there is learning. Students also need to have knowledge, competencies, and skills attitudes.

Research design, participants and method. For this study, the experimental research design was developed using the one-group pre-test post-test design methodology. Participants in the study were forty-two 2078 Winter Batch MPhil in Educational Studies students and nine lecturers at one of the universities in Nepal, who attended from February to July 2022. A Likert scale questionnaire was used to gather data on the applicability of students, lecturers, and experts, and "tests were used to collect data on the effectiveness of the learning outcomes components and student learning motivation" [21, p. 68].

3.3 Stage 3

Evaluation. Evaluation is a process to determine whether the developed learning modules is successful. Whether or not it meets initial expectations. Actually, each of the three stages (Stage 1, Stage 2, and Stage 3) is mentioned above. The analysis procedure of data used to determine whether the learning module is valid in accordance with Aiken's validity is as follows: A) assigning a score to each response between 1 and 5 (highly representative or extremely relevant); B) averaging the scores of every validator/experts for each indicator; C) using a formula, display the percentage of validity. (1):

$$P = \sum \frac{S}{[n(c-1)]} \tag{1}$$

D) Results based on expert testing, 0.766 is a valid value for the validity coefficient of Aiken items as the value ≥ 0.667 is valid [21].

The following steps are then used for each learning modules data analysis technique to be practical: Consider responses score based on criterion 1 (strongly agree), 2 (agree), 3 (neutral), 4 (disagree), and 5 (strongly disagree); b) add the scores for each indicator to determine the average score.; and c) calculate the value of practicality using the formula (2) as used by [21] and [34]:

$$P = \frac{S}{M} \times 100\% \tag{2}$$

In which NA = Ultimate Marks; S = Obtained marks; and M = Highest Marks; d) using criteria to assess the level of practicability. See Table 1.

Table 1. The category of practicability

Performance Level (%)	Category
82–100	Very Practical
71–81	Practical
66–70	Pretty Practical
60–65	Little Practical
0–59	Not Practical

The modules' effectiveness concerning learning goals and motivation is another consideration. Two outcomes, or factors, for learning are 1) learning completion and 2) pre- and post-test differences.

The selection criteria include that they: (a) are more appropriately used as a basis for developing e-modules, (b) the description appears to be clearer and more systematic, and (c) the development involves lecturers' and students' judgment, allowing the course to be revised before a field trial is conducted based on the findings of the evaluation, suggestions, and input from lecturers and students [31].

4 Results

4.1 Results of preliminary analysis

Demographic characteristic. Table 2 shows the participant demographic data whereby 30 (25 students and 5 lecturers) male and 21 (17 students and 4 lecturers) female participants participated in the process.

Table 2. Demographic Data of Participants

Participant Profile		Frequency
Male	Students	25
	Lecturers	5
Female	Students	17
	Lecturers	4
Total		51

Reliability. Reliability is the consistency of a questionnaire in achieving the same results. Cronbach alpha (α) was calculated using SPSS 25.0 software to establish the reliability between the data item, which evaluates the level of internal consistency between various measurement estimations. Hair states that the minimum value of α should be 0.7 [15]. The Cronbach alpha scores for all measurements are shown in Table 3, indicating that α for all measurements is more significant than 0.7, and they are reliable.

Table 3. Cronbach Alpha Values for All Measurements Measurement

Measurement	Number of Items	Cronbach Alpha α
Validity	9	0.91
Applicability	7	0.87
Effectiveness	4	0.78

Further, the ICT and e-Research course syllabus analysis showed that the course material met the criteria for the necessary competencies. Table 4 illustrates the outcomes of this syllabus evaluation.

Table 4. Outcomes of the analysis of the ICT and e-Research course outline

Outcomes	Experiences	Subjects Area
Students can conceptualize ICT and e-Research	• Understand the ethos of ICT and e-Research • Discuss the examples and application of ICT and e-Research	• Introduction and e-research timeline review • The current and evolving paradigm of e-research • E-resources Search Engine • E-resources Search Strategy • Analyzing the quality of e-resources • Reference e-resources (e. g., Zotero…)
Students can perform quantitative data analysis	• Students can develop digital tools for surveying tool for quantitative data • Students can perform a basic analysis of the data	• Digital tools for Questionnaire and Surveys (e.g., Google Form) • Telephone Surveys, Online Surveys, Mobile Surveys • Data Analytic framework (e.g.,. Mind mapping) • Data Gathering, Cleaning, and Validation (e.g., Ms. Excel)
Students can perform qualitative data analysis	• Students can develop digital tools for surveying qualitative data • Students can perform basic analysis of the qualitative data	• Semi-Structured and Unstructured Interviews • Focus Groups • Virtual ethnography, Netnography and Cybergraphy • Field Notes/ digital Documents • Digital tools in data handling: quotation, code, memo, group, segment, and networking (e.g, Atlas.ti…)
Students can compute and visualize cloud computing data	• Students can compute and visualize the cloud computing data (Bar graph, histogram, scatter plot, World cloud, Graphic timeline, infographic)	• Cloud computing and big data • Bar graph, histogram, scatter plot… • World cloud, Graphic timeline, infographic
Students can perform a review of the research reports/ articles	• Students can handle referencing, citation, and plagiarism tools	• Referencing and Citation • Paraphrasing, cohesive and coherence • Tools for Plagiarism Test • Ethics in e-research

The outcomes of the analysis of the ICT and e-Research course outline are presented in the form of a concept map, specifically the ICT and e-research components concept map. (See Figure 2).

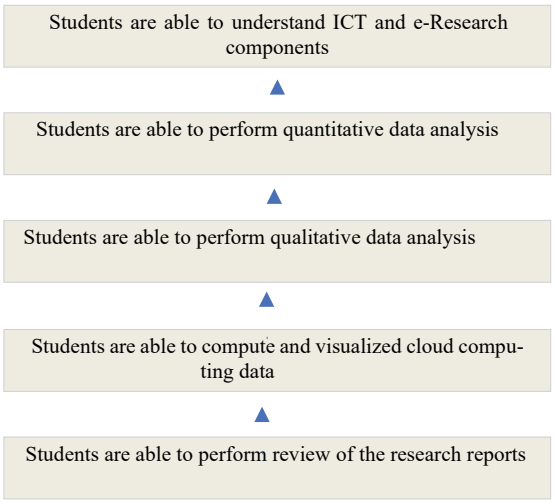

Fig. 2. ICT and e-Research component concept map

The outcomes of the student characteristics analysis. The analysis of student characteristics among 42 students includes the intellectual development of students aged 35 to 52. According to the revised Bloom Taxonomy, students of this age can design, perform, update, plan, produce, construct, and alter [4]. These skills enable independent learning and technological exploration of learning materials.

The format for developing e-learning modules is based on the Nepal Open University's modified e-module framework, comprised of (a) course syllabus, (b) contents, (c) course materials, (d) contents material, (e) references, (f) grading view, and (g) learning activities.

Course syllabus. The course syllabus describes the contents of the ICT and e-research module for learning and the learning topics. See Figure 3.

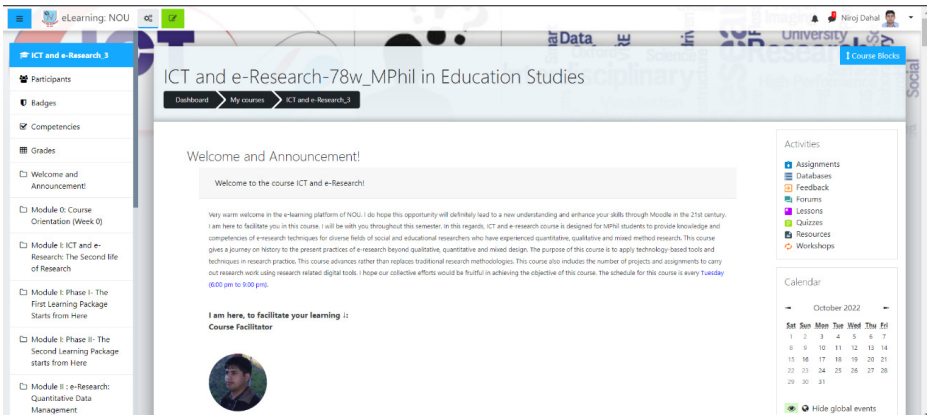

Fig. 3. Snapshot of course syllabus of the course

Contents. Content is created to facilitate students' comprehension learning of the contents of the modules. See Figure 4.

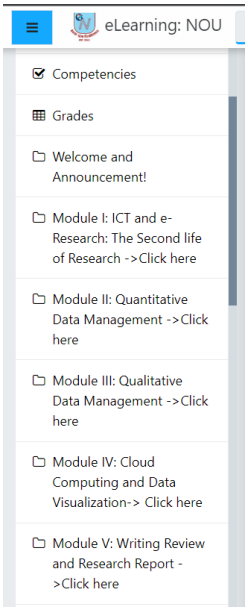

Fig. 4. Snapshot of contents

Curriculum information. The subject data consists of module summaries, learning contents, and module evaluations. See Figure 5.

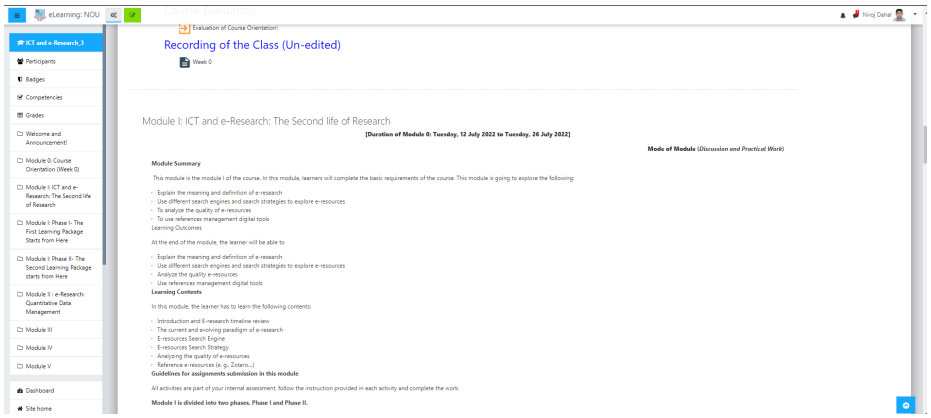

Fig. 5. Module information

Materials in the contents. The syllabus' learning objectives served as the basis for the material's design. In addition to text, the content is furnished with animations, images, and videos. See Figure 6.

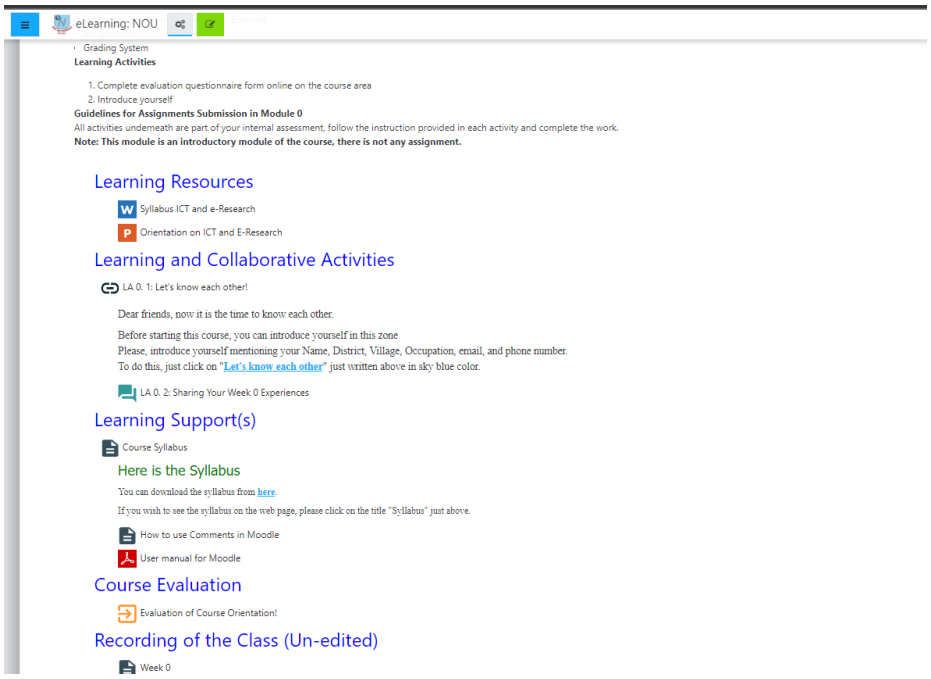

Fig. 6. Contents of the material in a Module

References. The bibliography sources utilized to develop and inform students about learning modules. See Figure 7.

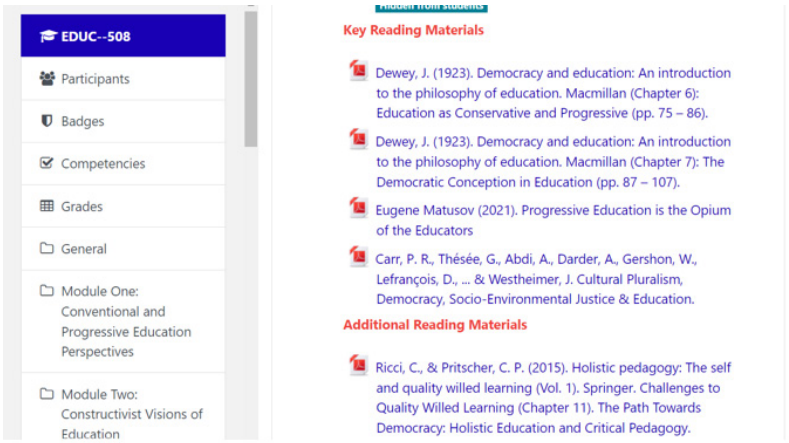

Fig. 7. Reference

Grading view. Through the NOU e-learning portal, grades are assigned. Tasks in any form (forum discussions, quiz, assignment, to name) that show right/wrong answers and corresponding task marks. See Figure 8.

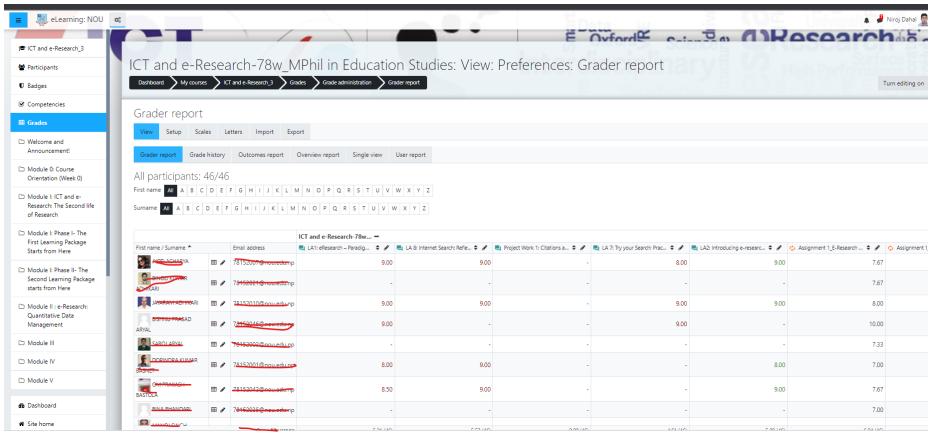

Fig. 8. Grading view

Learning activities in each of the modules as assigned but might be different. See Figure 9.

Fig. 9. Learning Activities view

4.2 Results for prototype 1

The outcomes are reliable indicators of how satisfied students are with their learning as a result of the module's design. See Figure 10, Figure 11, and Figure 12.

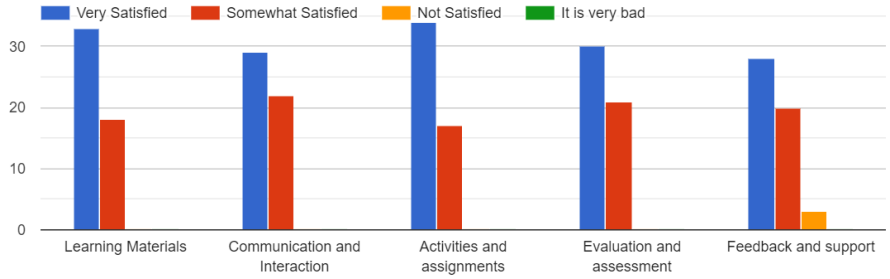

Fig. 10. The results of students' satisfaction with learning from Moodle learning environment

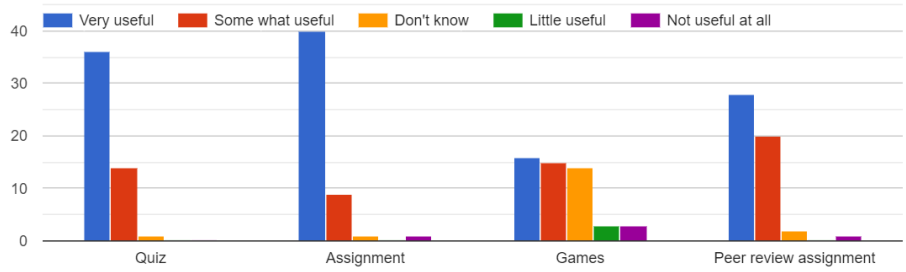

Fig. 11. Usefulness of the activities are useful in Moodle

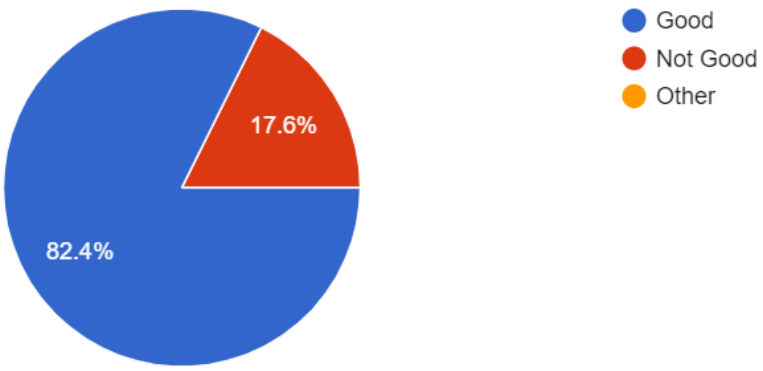

Fig. 12. Workload in the Moodle

Based on Figure 10, Figure 11, and Figure 12, the validity analysis test results were highly positive and classified as valid. Additionally, the validation outcomes with subject-matter experts and the outcomes of students' satisfaction with learning in the Moodle learning environment led to the declaration of validity for the e-learning module's contents.

4.3 Results for prototype 2

The following are the outcomes of prototype 2 for evaluating the usefulness of instructors and students.

Based on the lecturers' responses, the very practical category had an 88% practicality rating on average, indicating the higher level of practicality of the course ICT and e-Research. See Figure 13.

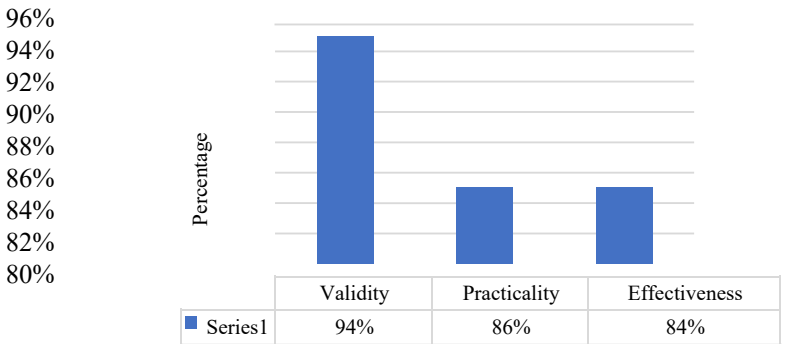

Fig. 13. Lecturers-based practicality

Figure 14 shows that practicality has a percentage value of 89.07% based on student responses, indicating that the e-learning modules are very practical.

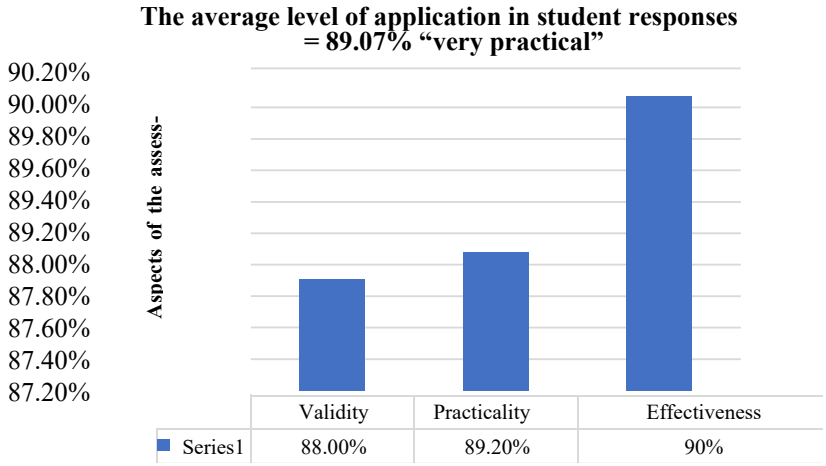

Fig. 14. Learners-based practicality

4.4 Rating outcomes

The evaluation results are presented repeatedly four times, representing the culmination of five distinct learning modules. Between the pre-and post-tests, an average of 86.90% of students evaluated the effectiveness of learning outcomes in terms of learning motivation, compared to 42 students (90.34%) who considered it in terms of traditional completeness aspects.

5 Discussion

The discussion is based on using an online learning module, validity, practicality, and effectiveness of the course ICT and e-Research. The ICT and e-research course is designed for MPhil students with experience with quantitative, qualitative, and mixed-method research knowledge and competencies in e-research techniques for diverse social and educational research fields. This course provides a historical journey to e-research practices beyond mixed, qualitative, and quantitative design. This course aims to teach students how to use tech-based tools and techniques for research. Traditional research methodologies are not being replaced but are relatively advanced in this course. This course also has a number of projects and assignments that require learners to conduct research using online resources.

Since this course is less theoretical and involves project-based activities, the instructional strategies are distinctive. As a result, the teacher will create a virtual learning environment (VLE), and student-centered teaching strategies will be applied. Nevertheless, the teaching methods for this course are split into two categories: theoretical

and practical. All three of these components—teaching, learning resources activities, and assessment—will be created in the learning management system (LMS) following the continuous assignment system (CAS) principle based on formative means for summative ends.

ICT and e-Research course is being designed and tested for one of the programs Educational Studies at Nepal Open University's MPhil in Social Sciences and Education. ICT and e-research are discussed in Modules 1 through 5: The second life of research, e-Research: Qualitative Data Management, Cloud Computing, Data Visualization, Writing Review and Research Report, Applications for the Use of ICT and e-Research, Components of ICT and e-Research, and their characteristics. Learners can download and open this course material online by visiting the Nepal Open University e-learning portal. The Nepal Open University's online learning portal will be used to implement the learning activities for each module. Students can be directed to understand the ICT and e-Research material concepts through the e-learning module [1]. The course ICT and e-Research is tested for validity, usability, and effectiveness when e-learning learning modules were delivered among students and lecturers.

Three aspects, namely (1) media appearance, (2) program simplicity, and (3) module utilization, have been validated by the media. Two validators evaluated this validation. The valid category had an average media validation result of 0.885. From the point of view of the media, the following things happened when the learning module was tested: The module has a good layout and is easy to use. The parts are linked to ICT and e-Research. According to the validation results that have been looked at, the media-based learning module is valid and works as expected. According to Plomp and Nieveen, the digital module must consider the size and type of the media display to make it easy to read [28].

Three aspects of the material were validated: (1) suitability of the material's content, (2) learning; and (3) summary. Two validators evaluated this validation. With a valid category, the average material validation result is 0.885. The outcomes of validating the learning module's material aspect demonstrate that the material is relevant to the learning objectives, its content is understandable, and the summary is displayed correctly. The learning module is valid from a material standpoint, according to the validation results that have been examined. This is consistent with the findings of the study. Alghamdi et al. stated that the interactive module could be used as a learning tool if the learning objectives, the current concept, and the ways the information is presented are considered [2].

A practicality test was done to see if the learning module could be used if instructors and students could understand it, and if students were interested in it. The lecturers said that 88.00% of the outcomes of the analysis of the questionnaire of the practicality fell into the category of "very practical." A product is practical if it meets the goal of having a practical value of more than 71%. From the student's perspective, the average percentage of practicality questionnaire results is 89.07%, which is very practical.

Based on the analysis of the questionnaires filled out by both instructors and students, the learning modules made for this study are easy to use, can be read by both instructors and students, and keep students' attention. In conclusion, the e-learning

module is said to be valid. According to the research result [16, 30], the digital learning module can be used as a resource for learning.

It was discovered that 90.30% of students were declared complete after integrating the learning modules via e-learning and that as many as out of 42 students 35 students received a grade of B+ or higher, highlighting the efficiency of the instructional module. If there are differences in learning outcomes between when the e-learning module is used, before it is used, and after it is used, this is another sign that it is working. As a result, the learning module achieves its intended outcomes of the learning. The study's conclusions show that learning outcomes that make use of online modules differ significantly from those that do not.

The study of Osman and Lee found that "digital learning modules with text, animation, and video can help students who have trouble understanding the material" [26, p. 395] by igniting their interest in and enthusiasm for learning, which enables them to understand concepts more thoroughly. The module's success can also be determined by how well it inspires students to learn. The usefulness of this test is judged from the point of view of both intrinsic and extrinsic motivation to find out what kind of motivation is present in the learning situation. The e-learning module can be deemed effective in terms of learning motivation based on an analysis of the data because 85.86% of the average results, after using the module, the effectiveness of learning motivation falls under the practical category. The virtual module is thought to enhance learning activities, motivation, and interest, per research findings.

6 Conclusions

This paper describes a process for creating online and distance courses for ICT and e-Research to enhance students' motivation and learning outcomes at the MPhil level. It presents a five-module e-learning course for ICT and e-Research and the learning strategy, learning tools, and assessment tools designed and developed using the Plomp model [27]. The descriptive analysis uses data analysis to explain the online course's validity, applicability, and effectiveness. The experimental research design was developed using the one-group pre-test post-test design methodology. Participants in the study were 42 students 2078 MPhil in Educational Studies students from Nepal Open University, aged 35 to 52, and 9 lecturers who attended from February to July 2022. A Likert scale questionnaire was used to gather data on the applicability of students, lecturers, and experts. Tests were used to collect data on the effectiveness of the learning outcomes components and student learning motivation. The format for developing e-learning modules is based on the Nepal Open University's modified e-module framework, comprised of (a) course syllabus, (b) contents, (c) course materials, (d) contents material, (e) references, (f) grading view, and (g) learning activities. The use of an e-Learning module that has been proven reliable, practical, and efficient for ICT and e-Research learning is advised for lecturers who teach a course on ICT and e-Research to enhance learning outcomes and student motivation. The most important results are results of preliminary analysis, validity: average material validation is 0.885; average media validation is 0.885, and practicality: more than 71% (very practical).

Likewise, a five-module e-learning course for ICT and e-Research has been created as a result of this research. This method of creating the course has been tried and tested. The outcomes demonstrate the validity, applicability, and efficiency of this course. The learning outcomes and motivation of the students in this course can be enhanced. Students are advised to become more engaged and motivated in their learning after completing this e-learning course in order to improve learning outcomes. The use of an e-learning module that has been proven reliable, practical, and efficient for the course ICT and e-Research, learning is advised for lecturers who teach a course on ICT and e-Research to enhance learning outcomes and student motivation.

7 Limitations

Due to time and resource limitations, this study was restricted to gathering data to create an effective, practical, and reliable process for developing an online and distance course of ICT and e-Research for 51 participants (42 students and 9 lecturers) from one of the universities in Nepal.

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10 Declarations

Conflict of interest There are no conflicts of interest that we should disclose.
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