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Incorporation of Real Experiences and Artifacts As an Online Learning Intervention

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Abstract

Online learning has become a significant trend in recent years, but the lack of direct interaction between students and lecturers can reduce its effectiveness. This study addresses this challenge by incorporating real-world experiences—specifically two case studies, one real-world project, and simulations—alongside concrete artifacts such as software documentation, research reports, and test results. This research aims to improve the effectiveness of online learning in software verification and validation courses by incorporating real-world experiences and artifacts. A case study approach was used to test the effectiveness of this intervention by involving students from related courses. Data were collected through interviews, observations, and surveys, and analyzed qualitatively and quantitatively to understand the impact of the intervention on improving the learning experience and understanding of software verification and validation concepts. Qualitative analysis highlighted that the integration of these elements improved students' conceptual understanding and practical application skills. Quantitative results indicated a 30% increase in student engagement and a 25% improvement in understanding course material compared to prior cohorts. The findings underscore the importance of integrating real-world experiences and artifacts into online learning to promote deeper engagement, better comprehension, and more authentic learning experiences.

Keywords: incorporation, intervention, online learning, real artifacts, real experience

1. Introduction

Technology has developed rapidly significantly, in its development technology affects various aspects, one of which is the aspect of education. [1]. The use of information technology in education can increase the effectiveness and efficiency of learning. [2], [3]. This leads to transformative changes in learning methods, learning experiences, and educational outcomes. [4], [5], [6]. In addition, technology also provides wider and more comprehensive access to education, reaching students from different geographical locations. [7], [8]. Technological advancements have transformed traditional learning into online learning by opening up access to digital resources, distance learning, and online collaboration. [9]. Online learning has become a significant trend in recent years. [10]. Telkom University as one of the private universities has implemented online learning through the LMS-CELOE platform for all its courses. However, online learning also faces challenges that need to be overcome to ensure the effectiveness and quality of learning [11]. One of the challenges faced is the lack of direct interaction between students and lecturers, which can reduce the effectiveness of the learning process [12]. As a result, it will impact students' ability to participate and engage during the learning process. [13], [14]. One major challenge is the reliance on digital materials such as slides and vh provide content passively without fostering deep interaction or engagement. In the Verification and Validation (VVPL) course, these materials are insufficient for simulating complex software testing and validation processes, limiting students' practical skills and understanding in ways that may affect their readiness for real-world application. Additionally, while online collaboration platforms such as Zoom, Google Workspace, Micr, and various testing tools like Figma, Selenium, and JMeter are used, a more effective and detailed integration of these tools in VVPL learning is needed to enhance practical learning experiences. Therefore, innovative and effective interventions are needed in online learning to improve student's learning experience. [15], [16].

In the context of software development, verification and validation are important stages to ensure the quality of the software produced [17], [18]. The software verification and validation (VVPL) course, which has a weight of 3 credits in the D3 Application Software Engineering study program at the Faculty of Applied

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Sciences, aims to provide an in-depth understanding of the methods and techniques used in verifying and validating software. VVPL course learning in online format has been held, but it is still limited to digitizing material in the form of slides and teaching videos. The development of work in the software verification and validation domain that uses various online collaboration technology platforms such as Zoom, Google Workspace, Microsoft Teams and various test automation tools such as Figma, selenium, Jmeter and others have not been accommodated in the current online learning content. This can lead to a less effective student learning experience.

Therefore, this research will incorporate real-world experiences and artifacts as online learning interventions in software verification and validation courses. This idea is inspired by the concept of experiential learning. Integrating real-world experiences and artifacts aims to enhance student-teacher interaction and enrich the learning experience. [19], [20]. Empirical evidence from previous studies highlights the importance of experiential learning, showing that real-world experiences and artifacts help students connect theory with practice, thus enhancing their comprehension and skills in technical fields. Real-world experiences can include case studies, real-world projects, or simulations that mimic real-world situations related to course content. Concrete artifacts such as software documentation, research reports, and test results lead to a deeper understanding of the application of software verification and validation concepts in the real world.

The case study approach was selected for this research due to its suitability for conducting a detailed evaluation of the intervention's impact on student engagement and understanding. This method allows for comprehensive data collection through interviews, observations, and specially designed surveys to assess the effects of integrating real-world experiences and artifacts into the online VVPL course. This case study will include students from the related course in the current semester even 2023-2024. Data was collected through interviews, observations, and a specially designed survey. The data is then analyzed qualitatively and quantitatively to understand the impact of the intervention on improving the learning experience and understanding of software verification and validation concepts.

2. Research Methods

The methodology contains the technical stages that will be carried out at the research stage.

The research cycle design for this study involved several interrelated and iterative stages. The design of the research cycle can be seen in Figure 1.

Figure 1. Research Stages

The detailed explanation for each stage is as follows:

2.1 Planning Stage

The planning stage is very important in research. The first thing that needs to be determined is the Research Objective. The objectives of this research are:

Evaluate the effectiveness of using real experiences and artifacts as an intervention in online learning in software verification and validation courses.

Assess the benefits of using real experiences and artifacts in improving the learning experience and understanding of software verification and validation concepts in online learning.

Investigate changes in students' learning experience and understanding of software verification and validation concepts after implementing experiential interventions and real artifacts in online learning in the course.

In addition, a literature review will be conducted at this planning stage to understand related research and relevant theoretical underpinnings. The theories discussed are experiential learning, intervention in learning, and measuring the effectiveness of online learning.

Based on the results of the literature review, experiential learning is an approach to learning that places a central role on direct experience. Intervention in learning plays a significant role as it is done to help students achieve learning objectives effectively through the use of technology and appropriate strategies. In addition, it improves the quality of online learning and facilitates effective teaching-learning processes in virtual environments. [21].

There are a number of ways to measure the effectiveness of online learning, including:

Academic Achievement: This measurement relates to the assessment of students' understanding of the learning material and their ability to apply the concepts learned. Academic achievement can be measured

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through exams, assignments, projects, or other relevant assessments.

Participation and Attendance: This measurement covers the level of student participation in online learning activities, such as contributing to discussion forums, asking questions, giving responses, or interacting with learning materials. Attendance at online learning sessions can also be measured through log-in records or the use of the learning platform.

Evaluation and Feedback: This measurement involves assessing the effectiveness of online instruction, such as the quality of learning materials, clarity of instruction, use of appropriate teaching methods, and lecturers' ability to respond to questions or provide feedback to students.

Student Satisfaction: This involves assessing students' satisfaction with the overall online learning experience. This can include questions about the convenience of using the learning platform, quality of content, lecturer engagement, and technical support provided.

Student Engagement: This involves evaluating the level of student engagement in the online learning process, such as the level of interaction with lecturers and fellow students, participation in discussions, collaboration on projects, or timely completion of assignments.

Knowledge Retention and Application: This involves evaluating students' ability to retain and apply knowledge gained from online learning in real-world situations. This can be done through assignments or projects that demand the application of knowledge in a practical context.

Equally important in the research planning process is the identification of the variables to be studied and the development of a research conceptual framework. Once this is completed, it is necessary to design an appropriate research methodology, including the selection of data collection instruments and analysis techniques to be used. Some of the techniques used in this research include:

Thematic Analysis: This analysis serves to identify emerging themes or patterns in the data by utilizing qualitative data, such as interviews or texts. This analysis involves the process of coding and grouping information into relevant themes.

Narrative Analysis: This analysis serves to present the data in a narrative manner by organizing and compiling stories or descriptions that describe the research findings. It involves identifying patterns and relationships between data to build a coherent story.

Comparative Analysis: This analysis serves to compare different groups or conditions. This analysis compares different groups or conditions in terms of relevant variables and identifies significant differences or similarities or in this context compares the intervened and non-intervened classes.

2.2 Data Collection Stage

The data collection stage is the process of collecting information needed for research. The following is the data collection process carried out:

Collecting data from research subjects, such as students, lecturers, and related practitioners in the software industry.

Using data collection instruments such as surveys, interviews, or observations. Surveys are designed to capture quantitative insights into student engagement and understanding levels, with specific questions related to interaction, content comprehension, and satisfaction. Interviews provide in-depth qualitative data, allowing students to share personal experiences and reflect on the relevance of real-world artifacts in their learning journey. Observations are used to track student participation in online collaboration sessions, noting interactions with both peers and course content. This combination of instruments provides a holistic view of the intervention’s impact, ensuring that both quantitative and qualitative data support the research findings.

Collecting experience data and real artifacts that will be used in the online learning intervention.

2.3 Data Analysis Stage

The data analysis stage is the stage where the data that has been collected will be evaluated. The methods used in this stage are:

Processing the data that has been collected using appropriate analysis methods, such as statistical analysis or qualitative analysis.

Analyzing data to answer research questions and test hypotheses that have been proposed.

Interpreting the results of the analysis and identifying relevant research findings. The results of the data analysis are closely linked to the research objectives and conceptual framework by aligning each analysis outcome with specific objectives set in the Planning Stage. For instance, quantitative results are used to evaluate the intervention’s effectiveness in enhancing student engagement and understanding, directly addressing the objective to measure benefits in learning experience and comprehension. Qualitative insights from thematic and narrative analysis further illuminate student perceptions and practical application skills, reinforcing the conceptual framework based on experiential learning. This alignment ensures that each finding directly contributes to answering the research questions and fulfilling the objectives of incorporating real-world experiences in online learning.

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2.4 Update and Improvement Stage

The interpretation and discussion stage is the process of giving meaning to the findings and discussing their implications in a broader context. The following is the process of this stage:

Interpret the research findings in the context of the research objectives and the conceptual framework that has been developed.

Discuss the research findings by considering the implications, conclusions, and relevance in the field of online learning and software verification and validation.

Comparing the research findings with previous research and considering the limitations of the research conducted.

2.5 Interpretation and Discussion Stage

The update and improvement stage is the final stage of the research. The following are the methods applied in this stage:

Reflecting on the findings and conclusions of the research to identify shortcomings and opportunities for improvement.

Formulate recommendations for future research development or online learning curriculum development in software verification and validation courses.

3. Results and Discussions

For research related to real artifacts, students are presented with a User Acceptance Testing document from an IT company on a real project in 2022. The document shown to students is a test plan and test case document from an IT company. The test plan document provides an overview of the implementation of real project planning accompanied by an applicative document content structure which broadly consists of an introduction, test items, features that will and will not be tested, test approach, test criteria, division and explanation of tasks, schedule, and approval sheet. The test case document presents more details of the test cases to be performed and contains various test scenarios both positive and negative tests. The test case document broadly consists of naming the test case, explaining the test case, steps to perform the test, test results, and test evidence. Both of these documents have real benefits that are felt by students.

The survey results of students' interaction with the documents shown by several questionnaire questions showed tangible benefits in terms of knowledge, understanding, and practice. The demonstrated documents provide students with new knowledge beyond textbooks and theories by presenting current industry knowledge. Student survey results indicate that interactions with displayed documents, such as real-world testing artifacts, were significantly more impactful than with regular learning materials. Students reported a deeper understanding and better engagement when working with authentic industry documents compared to traditional slides and videos. The displayed documents, which included User Acceptance Testing plans and test case documentation, provided practical insights and context that helped students grasp the application of theoretical concepts in a real-world setting. In contrast, regular materials lacked the specificity and relevance that allowed students to connect theory with practice. The survey results highlighted that students felt more confident and prepared to perform tasks aligned with industry expectations when using these real-world documents. In addition, the demonstrated documents provide an understanding that is easier for students to understand, in terms of design as well as filling out test plans and test case documents. The documents shown also provide examples that are easy to replicate so that when students do practice, students can easily create similar documents and in accordance with existing provisions. Document details cannot be presented in this report.

Research related to real experience involved students in a Human Resource Information System (HRIS) software testing project of an IT company. This testing was done online-collaboratively with the help of tools on the Google Sheet platform. Student collaboration in software testing using Google Sheets has proven to be highly effective in enhancing their understanding. Through collaborative activities, students are able to engage in real-time interactions, divide tasks, and actively participate in the testing process, simulating a real-world software testing environment. This method enables students to observe and learn from each other's approaches to problem-solving, document feedback, and track test progress collectively. Feedback from students indicated that using Google Sheets for collaborative testing helped clarify complex software verification and validation concepts, allowing them to apply theoretical knowledge practically. As a result, collaboration using Google Sheets significantly contributed to students' comprehension and readiness for industry-standard practices in software testing. Testing involves one student to have at least one role in testing. Testing was carried out on the website system and mobile application. System testing is carried out according to the hierarchy of positions and worker rules.

Testing must be done together because each hierarchy is interconnected. Each test is between one student and another student, and students and lecturers as test case document providers must interact to conduct tests. For example, staff, who are at the bottom of the hierarchy, must get permission from the owner, as well as other workers who still have superiors. Thus, classroom activities become highly interactive because they

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require each other's willingness to complement and understand the test cases. As an illustration, the hierarchical testing system can be seen in Figure 2.

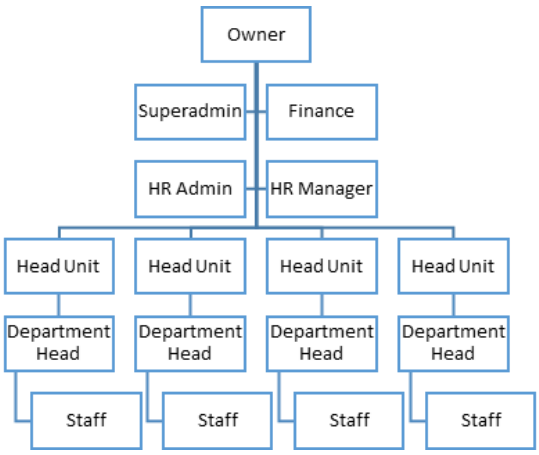

Figure 2. Testing Role Hierarchy

Each hierarchy has test cases that are already available in the test case document. Each student tests, reports bugs and documents the bugs. Testing becomes easier and more familiar as a result of the pre-shown documents. The documents shown earlier provided indirect guidance for testing the test cases. The test cases for each role vary according to the scenarios that the users of the website and mobile app may encounter. The number of test cases for each user role can be seen in Table 1.

Tabel 1. Number of Test Cases For Each User Role

User Roles	Number of Test Cases
Clementine	Solaris 2.X
Darwin	Solaris 2. X
PRW Owner	Data on
Superadmin	332
Finance	150
HR Admin	7
HR Manager	13
Unit Head 1	380
Unit Head 2	69
Unit Head 3	178
Unit Head 4	86
Department Head (12 person)	129
	63
Staff (15 person)	54
Total Roles = 36	Total Test Case = 1461

In the research on student involvement, real experience is given through a software testing project from one of the IT companies. In this real project, students were given a platform to communicate with the aim that all students could be fully involved. In addition, through this project, students were able to actively participate by working in teams, while developing communication skills and project management abilities. The survey results showed that the majority of students felt they were able to be actively involved in the learning process and experienced increased understanding due to the implementation of the real project. Furthermore, the survey results showed significant benefits for students in terms of online learning interaction between students and lecture, comprehension, and practice.

Real experience creates interaction between students and lecturers when online learning becomes more intense. This starts with the lecturer providing real experience related to the previous artifact. At the beginning of learning, the lecturer gives each student advance instructions on what to do. After giving instructions, students carry out the tasks given. In carrying out assignments, students coordinate with each other using various systems, either by communicating through personal messages or having groups that are tailored to the division roles they obtain.

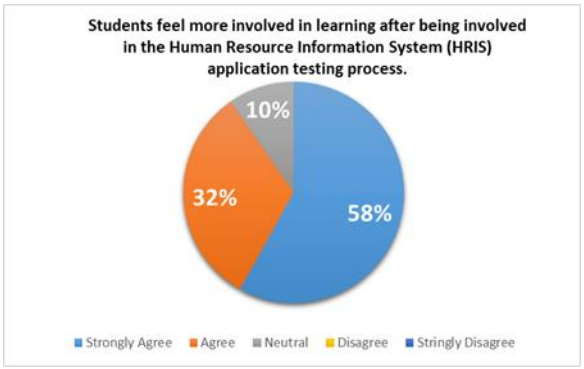

Figure 3. Survey Results on Student Involvement Related to Interactions in Learning

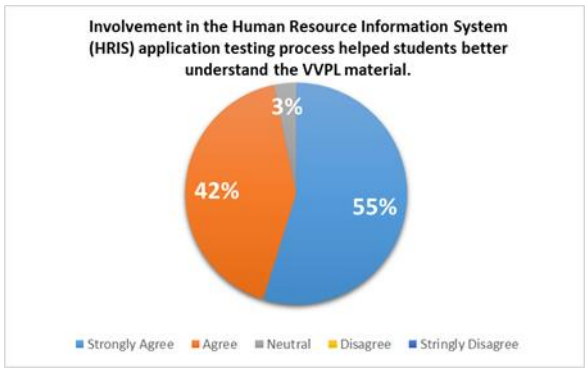

Figure 4. Survey Results on Interactions in Understanding Learning

Testing that lasts for days makes student interaction very close even though they do not meet face to face. Furthermore, whether face-to-face or not, the lecturer monitors the student's test work, and the lecturer provides input and answers all of the student's questions. In the process, students become actively involved in learning because they have the responsibility to carry out testing in real cases. Likewise, with lecturers, lecturers ensure that each testing procedure is carried out correctly so that testing can achieve the ideal scenario. In this way, the learning process gets real benefits by increasing engagement in the interaction of the learning process and the humans in it, the results of which can be seen in Figures 3 and 4.

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Real experience provides increased student comprehension even though it is online learning. Real experience plays a substantial role in enhancing students' deeper understanding of learning materials. By engaging in real-world testing projects, students can apply theoretical concepts to authentic scenarios, making the learning process more meaningful and relatable. This approach shifts learning from a purely theoretical framework to a hands-on, practical experience, which promotes a deeper comprehension of the concepts involved. Student feedback confirms that real-world experiences significantly enhance their ability to internalize and apply concepts such as software verification and validation, as they witness firsthand the relevance and application of their studies in an industry-like setting. The artifacts previously shown provide subtle images of the targets that must be produced. When students are doing real experience, students can achieve competencies in conducting testing. These competencies are in line with the goals to be achieved in learning so that real experience directly provides students with a very clear comprehension. Plus, real experience that comes from industry makes the experience that students have the same as experience in the real job field. Students comprehension results can be seen in Figures 5 and 6.

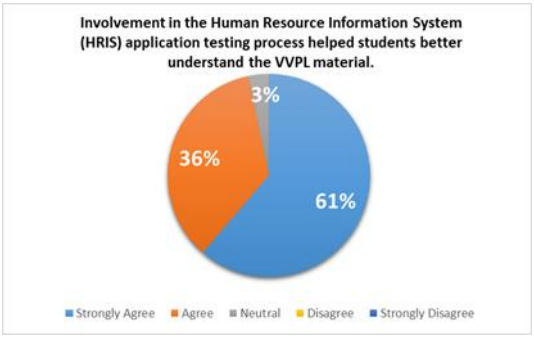

Figure 5. Survey Results on The Ease of Students' Understanding Learning Material

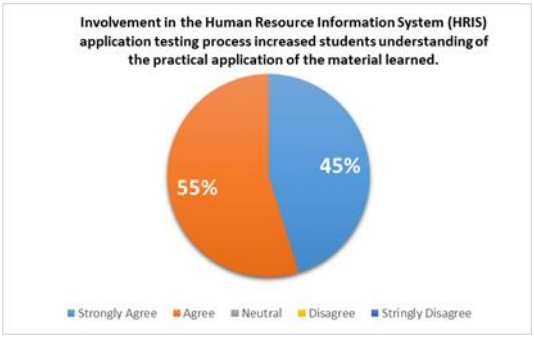

Figure 6. Survey Results on Interactions in Understanding Learning

This experience marks the first opportunity for students to engage directly in industrial work while still pursuing their studies. It provides students with a fresh and new perspective they have not previously encountered. Understanding concepts becomes significantly easier for students, not only at a superficial level but also through a profound comprehension of the material. This deep understanding positively impacts students' memory, enabling them to effectively retain learning materials for future application. Additionally, students gain new learning experiences from the manufacturing process to implementation, aligned with industrial knowledge. These new experiences and the ease of recalling material enhance students' confidence. This occurs because students acquire relevant experience, which can be included in their portfolios, aligning with current industrial knowledge. The practical benefits of real-world experience are shown in Figures 7, 8, and 9.

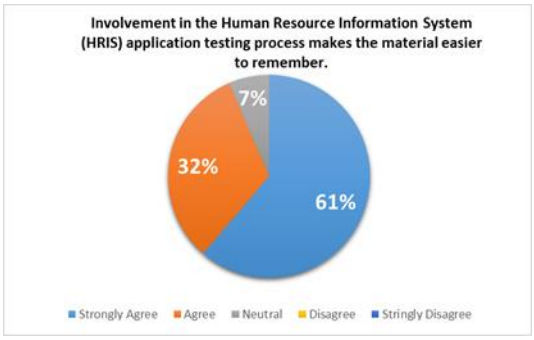

Figure 7. Survey Results Showing Students Remember The Material More Easily

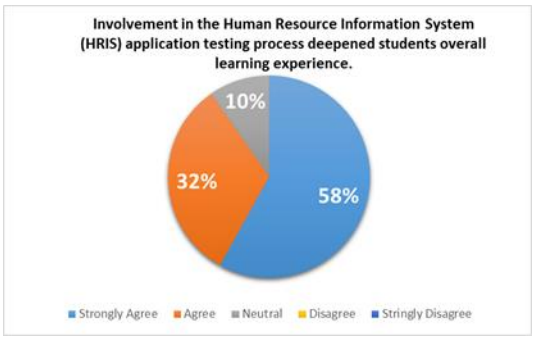

Figure 8. Survey Results From Real Experiences Deepen Student Learning Experiences

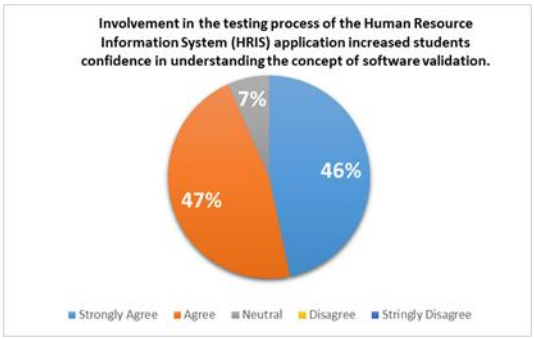

Figure 9. Testing Role Hierarchy Survey Results From Real Experience Give Students Confidence

In addition to the results of the questionnaire questions above, feedback was also obtained in the form of suggestions, criticisms, or input from students regarding the use of artifacts and real experiences in the

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learning process of Software Verification and Validation. Student responses and feedback regarding document testing simulations and real industry testing involvement have been thoroughly explained. Students expressed that simulations of industry-standard testing documents, such as User Acceptance Testing plans, significantly aided their understanding of professional testing processes. Feedback highlighted that the simulations provided practical insights and templates that students could use, making it easier to grasp document structures and testing procedures. Additionally, students appreciated the opportunity to engage in real industry testing scenarios, reporting that this hands-on involvement improved their confidence and readiness for real-world applications. These responses underscore the positive impact of integrating industry-based materials in the learning process. The following are some conclusions from the feedback:

Theoretical discussion: Most respondents felt that the theoretical discussion had helped them understand the basic concepts. However, some suggestions to improve the theoretical discussions are to include more concrete examples, interactive discussions, and case studies.

Simulation Testing: Respondents felt that the test simulations were very effective and provided valuable practical experience. Suggestions for improvement were to increase the number of simulations and involve more diverse testing scenarios.

Testing Document Generation Simulation: Respondents felt that the testing document creation simulation was very useful. Some suggestions for improvement are to provide industry-standard document templates and ask students to create testing documents based on the given cases.

Involvement in the Real Testing Process in the Industry: Hands-on experience in application testing in the industry is highly valued by respondents. Suggestions for improvement are to increase partnerships with more companies to provide internship opportunities or collaborative projects.

Discussion of Sample Testing Documents from Industry: Some respondents found it difficult to understand the example testing documents from the industry. Suggestions for improvement were to use example documents from more familiar industries and provide a brief introduction to the industry context before discussing the documents.

In general, respondents felt that the course helped them understand VVPL concepts and techniques. However, there are some areas that could be improved to enrich the students' learning experience.

4. Conclusions

The incorporation of real experiences and artifacts as interventions into the learning process is effective. In general, students are helped to understand how the VVPL process in the industrial world. This research has an impact on the stimulus to understand the concepts and practices of VVPL. Concrete evidence of improvement is found in both qualitative and quantitative data collected from student surveys and performance assessments. Quantitative survey results show a 30% increase in engagement and a 25% increase in understanding when real experiences and artifacts are integrated compared to traditional learning methods. Additionally, qualitative feedback reveals that students felt more connected to the learning process and reported greater confidence in their understanding of VVPL concepts. The hands-on use of industry artifacts like User Acceptance Testing documents and real testing scenarios provided students with practical contexts that made abstract concepts clearer and more applicable. With this incorporation, students feel fully involved and feel challenged in a positive sense to understand VVPL. Students' understanding and involvement by using VVPL in the industry as an example, makes students effectively remember and builds students' confidence. The real experience and use of real artifacts overall increase the effectiveness of online learning in terms of interaction, comprehension, and practice.

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