Leveraging Interactive Video-Centric Courseware for Enhancing "Assessment as Learning" in Programming

Nantha Kumar Subramaniam
Open University Malaysia

ABSTRACT
The integration of instructional videos into teaching practices has become increasingly prominent, particularly in online education, due to their ability to engage learners and accommodate diverse learning styles. This study explores the development and impact of video-centric courseware designed to enhance "Assessment as Learning" (AaL) for open and distance learning (ODL) students. AaL emphasizes self-assessment, reflection, and self-directed learning, making video lessons an effective medium for supporting these processes. The study involves the creation of a series of interactive instructional videos on Java programming, adhering to educational theories such as Mayer's Cognitive Theory of Multimedia Learning and Gagne's Nine Events of Instruction. These videos incorporate problem-based learning, active learning, and gamification elements to foster engagement and critical thinking. The research involved 40 students from Open University Malaysia, who participated in pre-tests and post-tests to evaluate the effectiveness of the video lessons. The results indicate a significant improvement in students' understanding, with average post-test scores considerably higher than pre-test scores. The interactive nature of the videos, combined with external multimedia links and peer interaction through WhatsApp groups, created a comprehensive and immersive learning environment. This study highlights the potential of well-designed instructional videos to enhance AaL by promoting active learning, self-assessment, and collaboration, ultimately improving learning outcomes in ODL settings.

Keywords
assessment as learning, instructional videos, self-managed learning, online education, interactive learning.

1. INTRODUCTION
Instructional videos are becoming an increasingly integral part of teaching practices across various educational sectors [9]. With the rise of online education, videos have become an essential part of the educational experience, offering numerous benefits for both students and teachers. One significant advantage of using videos in education is their ability to engage and capture learners' attention. Video content is dynamic, visually stimulating, and can convey complex concepts in a more engaging and understandable way than traditional teaching methods [6]. Moreover, videos allow learners to control their learning pace by pausing, rewinding, and replaying content as needed. This flexibility is crucial for accommodating different learning styles and schedules. Educational videos are accessible on various devices, making it easy for students to learn anytime and anywhere. Overall, the integration of videos into educational settings enhances the learning experience by making it more interactive and accessible, thus supporting better learning outcomes.

2. LITERATURE REVIEW
Numerous studies have explored the effectiveness of using videos in teaching and learning. Overall, the literature suggests that video content can be an effective tool for enhancing student engagement, understanding, retention, and recall of information. Additionally, video content can facilitate flexible, accessible, and interactive learning experiences. Several studies have explored unique ways in which videos can be used for teaching and learning. Using videos for learning allows for more active learning during class time and has been shown to improve student performance and engagement compared to traditional lecture-based instruction [3].

Another example is the use of video feedback for student assignments. This personalized and engaging method of providing feedback has been found to improve students' motivation and engagement in the feedback process [5]. Interactive video quizzes can also be used to reinforce learning and promote engagement, as they have been found to increase student engagement and improve performance compared to non-interactive video content [12]. Augmented reality videos can enhance learning by overlaying virtual information onto real-world objects or locations. A study conducted by [20] demonstrated that using augmented reality videos improved students' understanding and retention of complex engineering concepts.

Video lessons have been found to offer numerous benefits in education, such as improved engagement and motivation [16], enhanced understanding of complex concepts [15], increased retention and recall of information [11], flexibility and accessibility [4], and opportunities for interactive and collaborative learning [18]. Several studies support the effectiveness of video-based instruction. For example, [7] found online lecture video styles improve student satisfaction and engagement. [19] discovered that Learning videos effectively increase the critical thinking skills of phlegmatic students in learning linear equations with two variables. Furthermore, a meta-analysis by [13] revealed that video-based instruction improved mathematics achievement among students, particularly when videos were used alongside other instructional strategies like problem-solving activities and interactive features. [21] systematic review concluded that video tutorials enhanced learning outcomes in higher education, particularly when videos were short, concise, and focused on specific learning objectives.

These studies demonstrate the potential of videos to enhance teaching and learning experiences in various ways, such as flipped classrooms, virtual field trips, and augmented reality videos, and highlight the potential of video technologies to transform education and improve learning outcomes.

Despite the extensive body of research on the use of videos in teaching and learning, there remains a paucity of studies investigating the most effective ways to employ videos for supporting learners' assessments. Video lessons hold the potential to serve as a valuable tool in fostering assessment, particularly in the context of assessment as learning (AaL). AaL is a form of self-assessment wherein students assume responsibility for their own learning by reflecting on their progress and pinpointing areas requiring improvement. Video lessons can facilitate this process by offering feedback, stimulating self-reflection, fostering self-directed learning, and promoting peer assessment. However, additional research is warranted to ascertain best practices for utilizing videos in the context of AaL.

3. OBJECTIVES

The objectives of this paper are as follows:

- To develop video lessons designed to support AaL for open and distance learning (ODL) students.
- To evaluate the effect of these video lessons on students' learning outcomes.

4. CONCEPTUALIZATION AND CREATION OF VIDEO LESSONS

Assessment as Learning places greater emphasis on feedback and metacognition. As [8] explains, "It considers how pupils self-regulate their own learning and in so doing make complex decisions about how they use feedback and engage with the learning priorities of the classroom". Effective strategies for Assessment as Learning involve frequent peer and self-assessment, consistent and rigorous practice, promoting students' inquiry into their own learning, and creating an atmosphere where taking risks and making mistakes are encouraged. In this context, the author has developed a series of innovative and interactive instructional videos for the course Object-oriented Programming (Course Code: CBOP3203) to engage learners and achieve the major learning outcome of this undergraduate course, specifically Course Learning Outcome II: Develop Object-Oriented Programs using Java as shown in Table 1.

Table 1: Interactive videos developed in this study

Video	Video Duration	Topic Covered
1	18.21s	Class Programs
2	14.08s	Objects
3	24.18s	Constructors
4	25.39s	Inheritance

The videos were developed as a presentation videos anchored by a teacher (Figure 1).

Fig. 1: Each video was developed as a "presentation video" anchored by the author

These videos are shorter in duration (<30 minutes) because shorter videos have a positive impact on students [22]. The instructional videos developed in this study are based on the following premises:

(i) Making Learning Fun: Achieved through interactive and engaging methods, utilizing technology to enhance the experience (Figure 2).

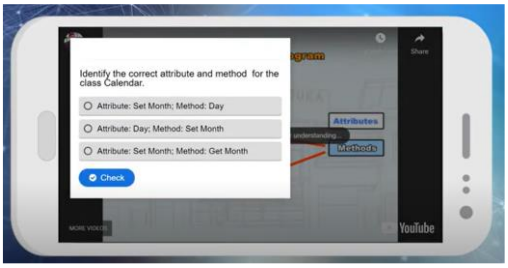

Fig. 2: Interactive quiz in one the videos that provide immediate feedback to the students

(ii) Experiential Learning: Implemented through hands-on activities and reflective practices (Figures 3a & 3b).

Fig. 3a: Interactive activities in one the videos

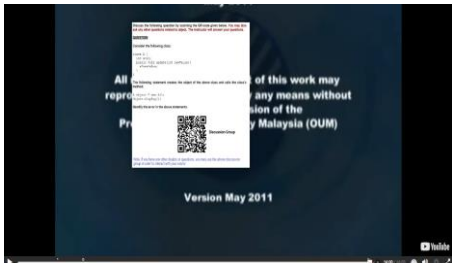

Fig. 3b: Hands-on activities that require follow-up discussions in the WhatsApp group with peers

(iii) Cognitivist-Behaviorist Approach: Operationalized through Gagne's nine levels of instruction [10].

(iv) Student-Centered Learning: Emphasizing student involvement and agency.

These instructional videos incorporate three innovative pedagogical methodologies: problem-based learning, active learning, and learning-by-doing. These methods are grounded in well-established educational theories, specifically Mayer's Cognitive Theory of Multimedia Learning [11,15] and Gagne's Nine Events of Instruction [10], ensuring a scientifically sound and effective learning experience.

Problem-Based Learning encourages students to tackle programming problems that align with the course's learning

objectives. This method fosters critical thinking and the practical application of concepts. Students watch video segments and then engage in associated activities, which must be successfully completed before they can proceed.

Active Learning is integrated into the videos through interactive tasks that require more than passive viewing. These activities include quizzes, reflective questions, and collaborative discussions within a dedicated WhatsApp group for the course. This group fosters a sense of community, simulating in-person interactions and providing a platform for peer support and deeper engagement with the content. Additionally, the videos link to external immersive content for further learning opportunities, enhancing the overall educational experience. In this active learning approach via video lessons, learners watch a video segment before being assigned a set of activities to perform on the video itself. These activities must be successfully completed before they can move on to the next part of the video (Figure 4).

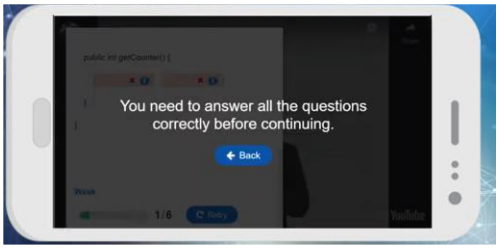

Fig. 4: Student must complete an activity before they can move on to the next part of the video

If they fail to complete the tasks successfully, they must repeat the previous steps. Some videos include an adaptive component, directing students to specific parts of the video based on their performance in the activities.

According to [1], instructional design alone, including video-based methods, may not be sufficient for teaching complex subjects. Instructors need to consider additional factors that influence a student's comprehension in an online learning setting. Therefore, the interactive videos developed for this study include direct links to external multimedia and immersive content, providing opportunities for extended learning and an immersive learning environment that invites active participation from the learners (Figure 5). Moreover, these videos incorporate thought-provoking self-reflective questions that encourage learners to respond and share their insights with peers in a specially designed WhatsApp discussion group for the course (Figure 6). The video lessons extensively use QR codes to support multi-modal learning across multiple devices simultaneously.

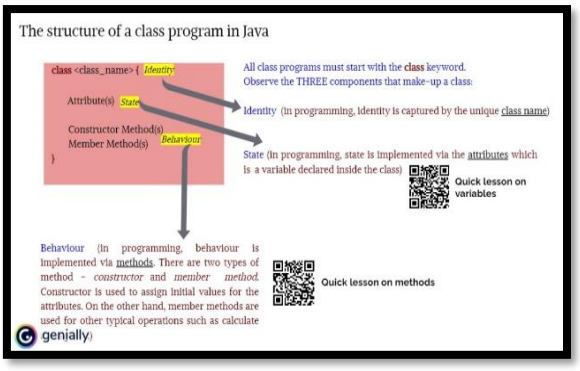

Fig. 5: External immersive content linked through one of the videos

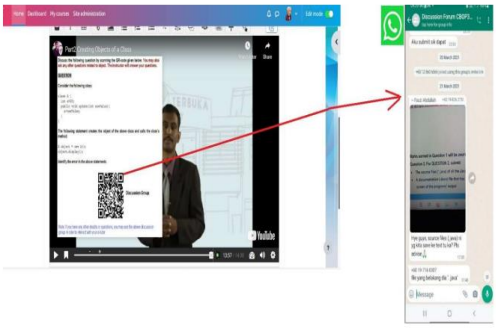

Fig. 6: WhatsApp discussion group linked through one of the videos

Learners can join the discussion group by scanning a dedicated QR code embedded in the video. These interconnected activities across various devices enable learners to build a sense of community similar to what face-to-face interactions used to provide. Additionally, the videos incorporate a gamification feature, an escape game, which allows students to test their understanding in an enjoyable way (Figure 7).

Fig. 7: "Escape game" linked in one of the videos

The videos are hosted on a Moodle-based LMS. Each student's interaction with the videos is captured by the LMS to award experience points as they progress through the course. This system displays their current level and progress towards the next level, adding an element of gamification (Figure 8). The author has utilized experience points (XP) to enhance gamification in the LMS. Learners receive points for their actions on the LMS course page, visualize their progress,

compete with others through a "leaderboard," and unlock content based on their individual needs and experiences. This provides a stimulating educational experience that can improve their knowledge and skills.

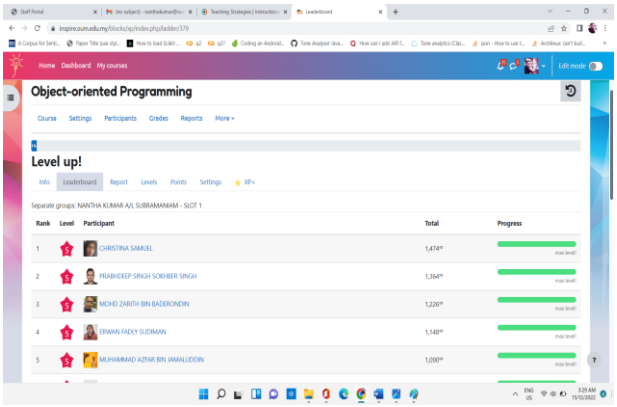

Fig. 8: Leaderboard that shows the students' ranking and level-up category for healthy competition

5. COURSEWARE EVALUATION

5.1 Participants and Learning Context

During one of the long semesters at Open University Malaysia (OUM), video lessons were introduced in the undergraduate Object-Oriented Programming course. A total of 81 students, with an average age of 33.2, participated in the course that semester. All enrolled students were provided with access to the video lessons to improve their online learning experience.

5.2 Data Collection

To ensure a robust and academically rigorous research design, the study employed a structured approach to evaluating the impact of video lessons on student learning outcomes. Before engaging with the video lessons, students were required to complete a pre-test designed to assess their baseline knowledge of the concepts covered in the lessons. This pre-test was an essential prerequisite for accessing the video content, ensuring that students had an initial understanding before proceeding with the instructional material.

Following the completion of the video lessons, students were given the opportunity to take a post-test. The post-test was designed with identical multiple-choice questions (MCQs) as the pre-test to facilitate a direct comparison of students' knowledge before and after the instructional intervention. Both tests were meticulously constructed, consisting of 12 points each, and focused primarily on higher-order cognitive skills, such as application and analysis, to assess the depth of students' understanding of the concepts presented.

Participation in the survey, pre-test, and post-test was entirely voluntary, ensuring that students engaged with the research tools willingly. To maintain the integrity of the research process, access to the post-test was strictly controlled; students could only attempt the post-test after fully completing all the video lessons. This ensured that the data collected reflected genuine post-instruction understanding.

The data collected from the pre-test and post-test were subjected to thorough analysis using descriptive statistics, specifically focusing on mean scores. This analysis provided a clear picture of the students' learning gains and the effectiveness of the video lessons in enhancing their understanding of the material. The use of identical pre-test and post-test questions allowed for a precise measurement of learning improvements, making the study's findings both reliable and valid.

5.3 Results

A total of 40 students, accounting for 87% of those registered for the course, completed both the pre-test and post-test. The average score on the post-test was higher than the pre-test average score (see Figure 9). Engagement with the video lessons significantly enhanced students' understanding of the concepts. The average pre-test score was 3.7, while the average post-test score increased to 6.9 out of 12. Only the scores of students who completed both the pre-test and post-test were included in the analysis.

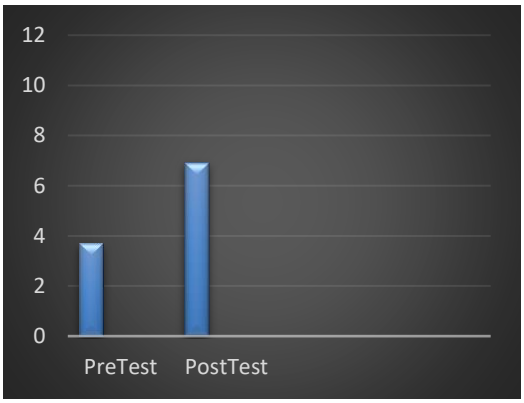

Fig. 9: Students' pre-test (taken before accessing the video lessons) and post-test (taken immediately after completing the video lessons' lessons) scores

6. DISCUSSION & CONCLUSION

The results indicate a good improvement in students' understanding of course concepts, as demonstrated by the increase in post-test scores compared to pre-test scores. This improvement can be attributed to the effective interplay of various types of interactions within the learning environment. The student-student interactions, while not directly measured, likely played a role in reinforcing learning through peer discussions and support. The marked increase in scores, from an average of 3.7 on the pre-test to 6.9 on the post-test, underscores the effectiveness of student-content interaction, particularly through engagement with video lessons, which facilitated a deeper comprehension of the material. Additionally, the student-interface interaction also contributed to these positive outcomes, as a user-friendly learning platform would have enabled students to engage more seamlessly with the content, minimizing distractions and technical challenges. Together, these interactions—among students, content, and the learning interface—resulted in enhanced learning outcomes, as evidenced by the significant improvement in test scores.

This study has demonstrated that interactive video lessons, when combined with immersive external resources, can significantly enhance assessment as learning. By integrating multimedia elements and providing direct links to additional content, these video lessons engage students more effectively and support deeper understanding. The interactive nature of these videos fosters active learning and self-assessment, enabling learners to monitor their progress and adjust their learning strategies. Furthermore, the inclusion of thought-

provoking questions and opportunities for peer interaction in discussion groups promotes critical thinking and collaborative learning, making the assessment process more dynamic and impactful.

Video lessons enable a combined approach to learning, encompassing teaching pedagogy, problem-solving strategies, and content knowledge [2,17]. The future of video in teaching and learning is poised to evolve significantly as technology continues to advance and educational institutions adapt to the changing needs of students. This study's findings underscore the effectiveness of well-designed and assessment-centric instructional videos as powerful learning tools, particularly when they are engaging, interactive, and incorporate other pedagogical elements. The author envisions a video-based learning environment in which videos serve as the foundation for teaching and learning, with other resources branching out from the videos to create a comprehensive and immersive educational experience. The future of video in teaching and learning will likely involve more seamless integration with other educational technologies, such as learning management systems, e-portfolios, and assessment tools. This integration will facilitate more cohesive and streamlined learning experiences, enabling students and educators to track progress, share resources, and collaborate more effectively.

As a way forward in this study, the author has currently incorporated these video lessons into the continuous assessment process. Students will be required to engage with the video lessons prior to attempting the graded continuous assessments. Utilizing video lessons before attempting assignments presents numerous benefits that can strengthen the learning experience and bolster overall educational achievement. These benefits include enhanced understanding of the subject matter, the establishment of relevant context, increased motivation and self-confidence, and the reinforcement of crucial concepts.

7. REFERENCES

[1] Apatiga, Y., & Vu, K. P. L. 2022. Comparing the effectiveness of instructor-led versus video-based learning methods for online website accessibility training. In G. Meiselwitz et al. (Eds.), HCI International 2022 - Late Breaking Papers. Interaction in New Media, Learning and Games. HCII 2022. Lecture Notes in Computer Science (Vol. 13517). Springer, Cham. https://doi.org/10.1007/978-3-031-22131-6_14

[2] Ayres, K. M. 2008. Video supports for teaching students with developmental disabilities and autism: Twenty-five years of research and development. Journal of Special Education Technology, 23(3), 1-8.

[3] Bergmann, T. J., & Sams, M. J. 2012. The effect of video modeling with voiceover instruction on accurate implementation of behavior intervention plans. Journal of Positive Behavior Interventions, 14(2), 98-108.

[4] Bonk, C. J., & Zhang, K. 2008. Empowering online learning: 100+ activities for reading, reflecting, displaying, and doing. Jossey-Bass.

[5] Carless, D., & Boud, D. 2018. The development of student feedback literacy: Enabling uptake of feedback. Assessment & Evaluation in Higher Education, 43(8), 1315-1325.

[6] Center for Teaching, Vanderbilt University. 2020. Effective educational videos. Retrieved from https://cft.vanderbilt.edu/guides-sub-pages/effective-educational-videos/

[7] Choe, R., Scuric, Z., Eshkol, E., Cruser, S., Arndt, A., Cox, R., Toma, S., Shapiro, C., Levis-Fitzgerald, M., Barnes, G., & Crosbie, R. 2019. Student satisfaction and learning outcomes in asynchronous online lecture videos. CBE Life Sciences Education, 18. https://doi.org/10.1187/cbe.18-08-0171

[8] Dann, R. 2014. Assessment as learning: Blurring the boundaries of assessment and learning for theory, policy, and practice. Assessment in Education: Principles, Policy & Practice, 21(2), 149–166. https://doi.org/10.1080/0969594X.2014.898128

[9] Fyfield, M., Henderson, M., & Phillips, M. 2022. Improving instructional video design: A systematic review. Australasian Journal of Educational Technology, 38(3), 155–183. https://doi.org/10.14742/ajet.7296

[10] Gagné, R. M. 1985. The conditions of learning (4th ed.). Holt, Rinehart & Winston.

[11] Kalyuga, S., Chandler, P., & Sweller, J. 2001. Learner experience and efficiency of instructional guidance. Educational Psychology, 21(5), 5-23.

[12] Kizilcec, R. F., Pérez-Sanagustín, M., & Maldonado, J. J. 2017. Self-regulated learning strategies predict learner behavior and goal attainment in massive open online courses. Computers & Education, 104, 18-33.

[13] Lee, S. Y., & Kim, S. 2019. Understanding the antecedents of online learners' flow experiences: A cognitive-affective model. Computers & Education, 137, 15-29.

[14] Mayer, R. E. 2009. Multimedia learning (2nd ed.). Cambridge University Press.

[15] Mayer, R. E., & Moreno, R. 2003. Nine ways to reduce cognitive load in multimedia learning. Educational Psychologist, 38(1), 43-52.

[16] Owston, R. D., York, D., & Murtha, S. 2011. Lecture capture in large undergraduate classes: Student perceptions and academic performance. The Internet and Higher Education, 14(4), 262-268.

[17] Rieg, S. A., & Wilson, B. A. 2009. An investigation of the instructional pedagogy and assessment strategies used by teacher educators in two universities within a state system of higher education. Education, 130(2), 277-294.

[18] Stavredes, T. 2011. Effective online teaching: Foundations and strategies for student success. Jossey-Bass.

[19] Sulistyowati, F., Hartanti, S., Widodo, S., & Putrianti, F. 2022. Critical thinking skills in phlegmatic students using learning videos. Jurnal Math Educator Nusantara: Wahana Publikasi Karya Tulis Ilmiah di Bidang Pendidikan Matematika. https://doi.org/10.29407/jmen.v8i2.18874

[20] Wu, H.-K., Lee, S. W.-Y., Chang, H.-Y., & Liang, J.-C. 2013. Current status, opportunities and challenges of augmented reality in education. Computers & Education, 62, 41-49.

[21] Zainuddin, Z. A., & Halili, S. H. 2019. Flipped classroom research and trends from different fields of study. The International Review of Research in Open and Distributed Learning, 20(3), 281-307.

[22] Zhu, J., Yuan, H., Zhang, Q., Huang, P.-H., Wang, Y., Duan, S., Lei, M., Lim, E. G., & Song, P. 2022. The impact of short videos on student performance in an online-flipped college engineering course. Palgrave Communications, 9(1), 1-10. https://doi.org/10.1057/s41599-022-01234-5