Work-in-Progress: Enhancing Motivation through QuizEmbedded Videos in Flipped Project-Based Learning: Evidence from an Undergraduate Computer Science Course

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Abstract

This work-in-progress paper examines the relation between design of quiz-embedded videos in a flipped learning context and students' intrinsic motivation through Self-Determination Theory. The findings showed that the design of videos has alignment with students' intrinsic motivation.

Motivation of Research

Flipped project-based learning (FPBL) has gained attention in computer science education for fostering active learning [1]–[5]. While prior research has shown that FPBL can enhance computer science students' learning motivation [1], [3], [4], there remains a need to understand how specific design elements such as quiz-embedded videos and hands-on activities of FPBL contribute to students' motivation. The purpose of this study is to examine the association between the design and implementation features of online instructional videos and students' intrinsic motivation. Grounded in Self-Determination Theory (SDT) [6], the study explores how key video features support students' psychological needs for autonomy, competence, and relatedness, and how these experiences, in turn, are associated with their intrinsic motivation to engage in learning activities. In this framework, autonomy refers to one's willingness, choice and control to complete quiz-embedded videos, competence reflects confidence and perceived progress on videos and relatedness emerges from feeling connected with course and class community.

Research Question

How are features of online video design and implementation associated with students' intrinsic motivation, and to what extent is this relationship explained by their satisfaction of autonomy, competence, and relatedness?

Summary of Intervention

This study presents the exploratory phase of a larger design-based research (DBR) project. It was conducted in an upper-level computer science course at a four-year university and involved 18 junior and senior students who participated in 14-week FPBL modules focused on embedded programming with drone technologies. Students engaged with asynchronous video lectures prior to attending hands-on, collaborative project sessions. The course was held twice per week on Tuesdays and Thursdays. Because students required adequate space to code and fly their drones, they were divided into two groups (Group A and Group B). Group A participated in projects sessions on Tuesdays, while Group B participated on Thursdays. On days when one group attended project sessions, the other group engaged in flipped learning by working independently with the course materials.

The pre-class, quiz-embedded videos were developed using Canva and Notebook LM to provide formative assessment opportunities and immediate feedback. Each week's videos included the instructor's lecture notes as well as the assigned scientific articles for the week. The videos did not contain source code; instead, they offered prompts and guiding questions to encourage

students to think from different perspectives in preparation for project sessions. The length of the videos were approximately 4 to 7 minutes. Each video included three quiz questions that appeared immediately after the relevant content was presented. There was no specific timeline to questions occur. To continue watching the video, students were required to answer questions. Although students did not receive immediate feedback within the video itself, their quiz results were made available to them later through the LMS.

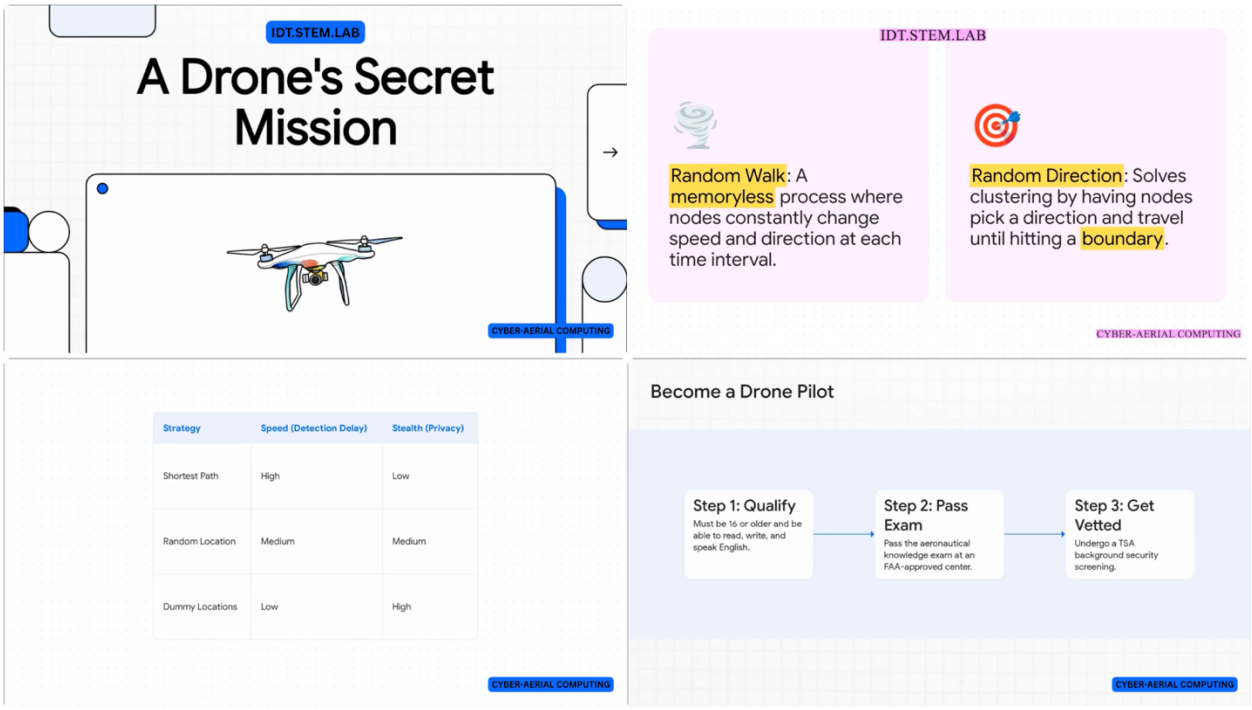

Figure 1. Screenshots from Videos

Data Collection and Analysis

Participation in the study was voluntary, and informed consent forms were obtained from 18 participants at the beginning of the semester. Multiple data sources were collected, including pre-, mid-, and post-surveys, interviews, and quiz results, to inform future refinements of the course design. The pre-survey was administered in person at the beginning of the semester, whereas the mid-survey (administered after the midterm exam) and the post-survey (administered at the end of the semester) were collected online. Seven interviews were conducted in pair or individually by the two principal investigators. In addition, projects session observations and pre- and post-instructor interviews were collected as secondary data sources. Four research assistants of the project observed project sessions every week, and two assistants interviewed the course instructor at the beginning and end of the semester. Descriptive statistics were used to examine the patterns in students' motivation across the pre-, mid-, and post-course surveys. These were complemented by a deductive coding approach guided by SDT to analyze open-ended responses and interviews. Interview and open-ended response data were further analyzed using thematic analysis to identify recurring patterns related to students' feelings of autonomy, competency and relatedness.

The survey questions were developed by assistants of the project based on feeling of autonomy, competency and relatedness in SDT and questions were validated by two experts. Each question pointed on one of the feelings in SDT. Beside Likert-scale questions, there was one open ended question that students can share their experiences with quiz-embedded videos.

Summary Findings

Students reported relatively high levels of perceived autonomy (M = 4.13, SD = .95). This finding was supported by two qualitative themes: choosing time and choosing pace. Students emphasized that being able to decide when to watch the videos and to proceed at their own pace supported their sense of autonomy. In addition, students indicated that the length of the videos was appropriate (M = 4.47, SD = 0.71), the timing of the embedded questions was well placed (M = 4.05, SD = 0.74), and the number of questions felt reasonable (M = 4.47, SD = 1.00), all of which further supported their sense of control over their learning. However, a constraining theme also emerged: students reported that being unable to see their quiz scores immediately after completing quizzes reduced their sense of control and motivation to fully engage with the videos. Although students' quizzes later announced in the LMS, they said they would prefer the grades immediately. Students' survey responses indicated that students have a relatively high perception of relatedness (M = 3.64, SD = 1.88). However, seven students noted a lack of clear connection between the online videos and the in-person project sessions, which diminished their sense of connection to the course. Observation notes supported this finding that the instructor did not consistently make explicit links between online video content and lab activities during project sessions. In contrast, instructor interviews revealed that the selected articles and lecture notes were intentionally aligned with the lab projects. Students also reported a high level of competency (M = 3.90, SD = 1.04). This was corroborated by interview and open-ended survey responses. Students indicated that the visual design and length of the videos supported their learning and strengthened their sense of competence. However, some students expressed concerns about the timing of certain quiz questions, noting that questions occasionally appeared before the relevant content had been fully explained.

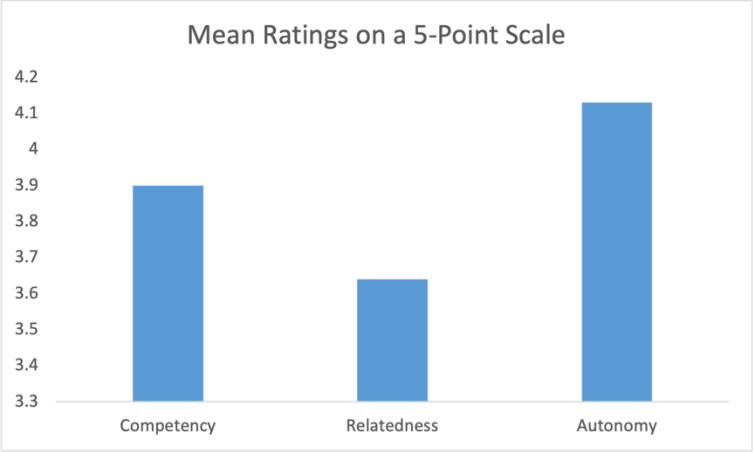

Figure 2: Mean Likert Scale Scores for Autonomy, Relatedness, and Competence

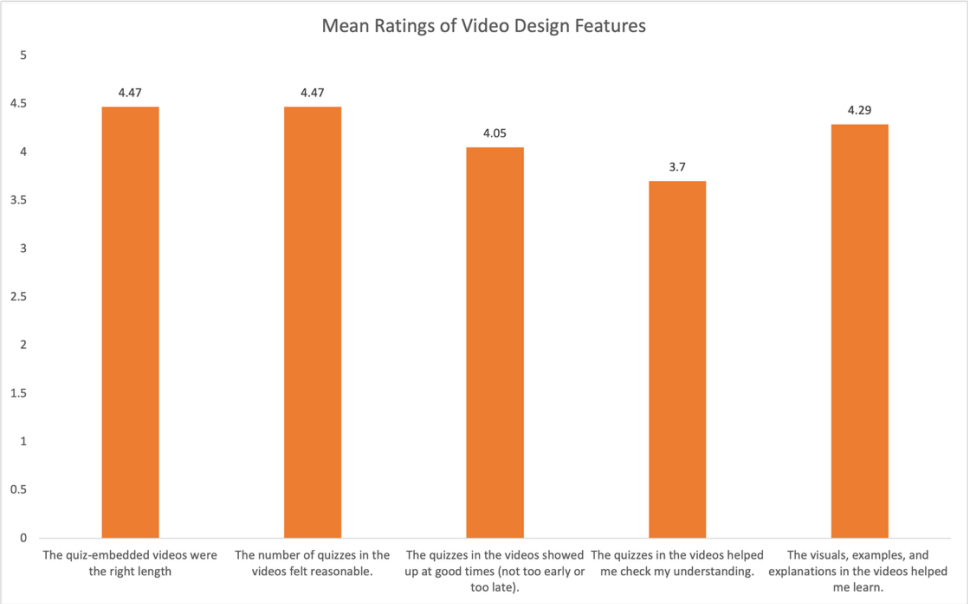

Figure 3: Mean Scores of Instructional Video Design Features

Discussion

The findings suggest that the quiz-embedded videos supported students' intrinsic motivation by fostering their satisfaction of relatedness, autonomy, and competence. Students' ratings for relatedness, autonomy, and competence were all above 3.50 out of 5, providing evidence to show students were generally intrinsically motivated. Overall, students expressed positive perceptions of the quiz-embedded videos and found them helpful for their learning. However, students who did not favor quiz-embedded videos tended to complete fewer of them.

Several students reported that the online activities felt disconnected from the lab sessions, making them perceive the online and in-person components as separate courses. Although the instructor intentionally selected articles and lecture notes to support students' coding skills, students indicated that they had difficulty aligning these materials with their coding processes during project sessions. This misalignment may have negatively affected students' feelings of relatedness and competence.

Despite some concerns about video design, the findings suggest that the overall design of the videos promoted students' sense of autonomy and competency. Students noted that the assigned articles were difficult to understand, whereas the videos presented content in manageable segments with clear, non-distracting visuals, which facilitated learning. Also, being able to plan their own learning by choosing when and at what pace to watch the videos supported their sense of autonomy. Not being able to see quiz scores immediately after completion emerged as the most frequently mentioned concern in the qualitative data, which may negatively influence students' perceived autonomy.

Recommendation for Future Design

Next year, the designer team could incorporate additional elements that that more clearly convey instructor care and presence. For example, encouraging feedback messages after quizzes and more personalized examples that address students' common misconceptions could strengthen students' sense of relatedness. To support autonomy, the team could add a feedback mechanism that shows students' quiz scores, incorrect answers and brief explanations, as well as allow students to skip and revisit questions. The timing of embedded questions should also be adjusted to better align with the video content. Finally, the design team should work with the instructor to create clearer connections between the online videos and in-person lab activities.

Appendix

Sample Survey Items for Autonomy, Relatedness and Competence

- I did the online activities because I wanted to understand the material.
- I could decide when and how to complete the online activities.
- I felt I could control how much time I spent on each online activity.
- When I completed the online activities, I felt part of the class community.
- I felt that the instructor cares about my progress in the online portion of the course.
- I felt a sense of connection to the course through the online activities.
- I felt confident completing the online activities.
- The online activities helped me understand the course content.
- The online activities helped me build knowledge needed for the lab projects.

Sample Interview Questions

- How did the videos contribute to your learning experience overall?
- Did you find them helpful or distracting? Why? (e.g., understanding concepts, articles, or lecture notes)
- What did you think about the embedded video quizzes like their length, timing, number of questions?
- Were there any specific video features (like visuals, examples, or explanations) that helped you learn better?
- How did you manage your time and keep up with the online materials each week?
- Did this course encourage you to reflect on your own learning process or the way you approach tasks?
- How comfortable did you feel using the online tools and platforms in this course?

References

[1] M. Chis, D. Moldovan, and P. Murphy, “The impact of flipped project-based learning on student engagement and achievement in computer science,” Computers & Education, vol. 128, pp. 187–200, 2018.

[2] Y. Dori, D. Holzer, and A. Levin, “Project-based learning in engineering and computer science education: Effect on learning outcomes,” European Journal of Engineering Education, vol. 45, no. 3, pp. 395–410, 2020.

[3] M. Fetaji, B. Fetaji, and M. Ebibi, “Applying flipped classroom and project-based learning to enhance learning effectiveness,” Education and Information Technologies, vol. 24, no. 6, pp. 3681–3697, 2019.

[4] S. Malik and Z. Zhu, “Evaluating the role of flipped learning in computer programming courses,” IEEE Access, vol. 10, pp. 16259–16270, 2022.

[5] L. Sanchez-Romero, J. Ruiz, and M. Garcia, “Active learning through flipped project-based methodology in computer science education,” International Journal of Educational Technology in Higher Education, vol. 16, no. 1, pp. 1–15, 2019.

[6] R. M. Ryan and E. L. Deci, “Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being,” American Psychologist, vol. 55, no. 1, pp. 68–78, 2000.