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Enhancing Graduate Studies with Interactive Videos: Uncovering Student and Instructor Perspectives on Motivation, Self-Efficacy, and Future Intentions

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Laboratory-based courses and research studies play a crucial role in many fields in higher education. With the idea that the creation and use of interactive materials of experimental periods can be a potentially transformative teaching and learning experience, graduate students and instructors have been trained to design and integrate interactive videos as part of their experimental studies. This study aimed to explore self-efficacy, motivation and future intentions of graduate student and instructors to develop and use interactive videos as a learning material. Using a mixed-method approach via a questionnaire and semi-structured interviews, data were collected from graduate students and instructors before and after face-to-face/online trainings on the design and use of interactive videos. Data were analyzed descriptively for the survey items on motivation and perceptions on the use of interactive videos for

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graduate experiments. For the interview data, the data were analyzed based on specific themes. The results showed that the self-efficacy of the participants have been increased and they had high motivation and strong intention to use interactive videos for a number of reasons. As the participants' self-efficacy has improved, they reported positive perceptions regarding the contributions of interactive videos to their understanding of experimental processes. The findings showed that graduate students shooting an experimental process with their presence can yield better learning outcomes for other graduate students. The results can be valuable for demonstrating potential use of interactive videos during laboratory-based educational and research contexts.

Introduction

Research and laboratory practices in graduate education are typically supported by experienced students, such as PhD candidates, or experts who provide guidance to beginners. Since the Covid-19 pandemic, there has been an increased emphasis in international reports (e.g., European Commission, 2020; UNESCO, 2021) on enhancing graduate education through digital technologies and educational pedagogies. Leveraging these insights, this practice can be transitioned to a digital and interactive environment, enhancing digital competencies and sustaining graduate processes. The use of interactive videos in this context has significant potential, as it provides a dynamic and engaging learning experience by having the learner actively respond to the questions that are posed (Dieck-Assad et al., 2020; Merkt et al., 2011). In addition, interactive videos can be accessed anytime and anywhere, making them a flexible learning tool, which is important in graduate education, where students often juggle multiple responsibilities (Bal et al., 2020).

There are efforts in publishing videos of the laboratory research of graduate studies. One of the existing platforms for experimental studies is the Journal of Visual Experiments (JoVE) and JoVE Science Education, which has been published as a peer-reviewed journal, and the digital platform with sample video demonstrations under the name of JoVE Lab Manual. It is an extensive source for higher education students and instructors, and needs to be expanded by every researcher. Shooting and developing videos is still regarded a complex task that can be conducted by professionals, and therefore it is hard for researchers to shoot the long-lasting periods of laboratory work with those professionals. However, given the capabilities of the current technologies, it is believed that any researcher with a mobile phone with a camera can record the videos of experimental processes and create as instructional material in the form of an interactive video. The self-efficacy and motivation of graduate students for such a task gains importance, as they are basic requirements for the fulfilment of a desired behaviour, especially in the use of technology in education (Albion, 1999; Bandura, 1997; Keller, 2016; Zimmerman, 2000).

Interactive videos enable the learning process to be more engaging and effective, increasing satisfaction (Dieck-Assad et al., 2020; Doğru et al., 2023; Wachtler et al., 2016; Zhang et al., 2006) and skill acquisition (Schwan & Riempp, 2004). Hence, they can offer diverse opportunities for graduate students and instructors. They can be used as a self-study material for other graduate students, and as an instructional material for instructors to be used in their undergraduate and graduate teaching, and can offer an effective way for the dissemination of research studies as a digital resource to all scholars around the world. However, a very limited number of studies have been conducted that analyse the perspectives of graduate students or instructors who serve as advisors across diverse fields regarding the feasibility of designing, developing, and using interactive videos for their graduate studies. This indicates a dearth of research examining the perspectives of graduate students and instructors regarding the utilization of interactive videos in experimental processes. Additionally, further investigation is required into the motivations and perceived self-efficacies of graduate students, given their potential role as developers of the interactive videos in laboratories. Thus, the purpose of this study was to investigate the motivation, perceived self-efficacy and future intentions of graduate students and instructors regarding the development and use of interactive videos as a learning material. The following research questions were tackled in order to achieve this goal:

- What is the level of motivation of the graduate students in designing and using interactive videos?
- How did the self-efficacy for developing interactive videos changed after training?
- What are the opinions of the graduate students and instructors who serve as advisors of graduate students about using interactive video in experimental processes?
    - Which advantages do they consider important? What are the perceived affordances of interactive videos for experimental studies?
    - How do the instructors and graduate students intend to use interactive video in the future?

Focusing on diverse fields that utilize experimental and laboratory-based research studies including engineering, science, aeronautics and others, the study's outcomes are anticipated to offer valuable insights for constructing a framework and roadmap to improve graduate research endeavours that incorporate laboratory work through the utilization of interactive videos. In periods that require remote communication, such as the Covid-19 pandemic, or in situations where there is a need to gain experience in experimental studies, the continuity of projects or research can be enhanced. At the same time, a concrete, traceable, improvable, and motivating digital information source is created for the student just beginning graduate education, fostering both the advisor's ability to guide and the student's ability to learn and innovate effectively.

Theoretical Framework

The researchers employed a comprehensive theoretical framework that drew from three key approaches to inform their study. Firstly, they delved into the intricate issues associated with experimental processes, including laboratory studies, to shed light on the complexities and challenges that graduate students or instructors face during research endeavours. This approach provided a thorough exploration of the practical aspects of graduate research, highlighting the difficulties to improve research outcomes. Secondly, the researchers examined the pedagogical affordances of interactive videos, seeking to understand how these digital tools could enhance the learning experience in a graduate research context, particularly within laboratory studies. This approach offered insights into the potential of interactive videos to facilitate more effective and engaging educational practices. This approach allowed the researchers to pinpoint areas where interactive videos could be most beneficial in facilitating the laboratory studies of graduate research. Lastly, the framework encompassed the dimensions of self-efficacy, motivation, and intention in using technology. By examining the self-efficacy and motivation of graduate students and instructors when it came to integrating technology into their research and learning processes, the researchers sought to unveil the psychological factors that influence the adoption and utilization of digital tools. This approach provided a deeper understanding of the individual and motivational aspects that drive the use of interactive videos in graduate education. These three interconnected approaches formed the theoretical framework for the study, providing a multifaceted perspective on the use of interactive videos in the realm of graduate research and education. They were complementary in addressing practical, pedagogical, and psychological dimensions, thereby ensuring a holistic understanding of the potential and challenges associated with the integration of interactive videos into graduate research practices. This comprehensive framework was directly relevant to the research questions, as it provided a clear rationale for exploring how interactive videos can enhance laboratory studies, improve learning experiences, and be effectively adopted by graduate students and instructors.

Interactive Videos as an Instructional Material

Instructional materials are resources that transmit information to learners to reach particular learning objectives. Initially gaining prominence in educational settings due to their dynamic visual nature (Cuban, 1986), videos have now found extensive utilization in both distance education and traditional classroom settings. This popularity extends to educational films, television programs, and documentaries (Mayer et al., 2020; Saettler, 2004). Videos have become a crucial instructional material due to their ability to appeal to multiple senses (Mayer, 2005; 2014a; 2014b), the option to add various elements to the video via software, and their ability to make abstract concepts closer to concrete (Bates, 2005). Educational videos, which have found a medium in which the production and sharing of information becomes easier with the Internet, have gained more widespread use with mobile technologies.

One of the biggest limitations of using videos in education is the lack of mutual communication and the one-way flow of information (Uğur & Okur, 2016; Smaldino et al., 2014). This situation has caused educational videos on television to be included in the literature as a "talking head". However, this interaction limitation can be eliminated with various digital tools and regulations developed in recent years (Preradovic et al, 2020; Uğur & Okur, 2016; Wachtler et al, 2016) including increased capabilities of mobile phones and interactive video preparation programs.

Interactive videos facilitate communication between the learner and video elements. For instance, a query is presented on the screen, and once answered by the learner, a message of warning or congrats is displayed depending on the answer, or the learner is redirected to the video section correlating to the question. Therefore, interactive videos provide significant contributions in terms of attention (Bos et al., 2019), self-directed learning (Sinnayah et al., 2021), and learner engagement (Bakla & Mehdiyev, 2022). The use of pop-up questions in interactive videos has been demonstrated to enhance learners' engagement with the course content (Doğru et al., 2023). Accordingly, interactive videos transition learners from being passive onlookers to active participants.

Based on the Cognitive Theory of Multimedia Learning (Mayer, 1997), it can be argued that interactive videos are helpful in creating information for multiple channels, and in organizing and integrating information in the brain. The segmenting principle defined as “breaking the lesson into manageable learner-controlled segments” by Mayer and Pilegard (2014, p. 318) has also been linked to the interactive videos for two reasons (Spanjers et al., 2010): giving learners “time to process information shown earlier before new information is displayed” and “structuring a video into meaningful sections to help learners realize the overall organization of a video’s content” (Ploetzner, 2022, p. 13). As interactive videos are used in a variety of fields, including medicine, engineering, education, business, professional development, and teaching (Cresswell et al., 2019; Firdaus et al., 2021; Howard et al., 2021; Karmila et al., 2021; Taslibeyaz et al, 2016), it is imperative to investigate the factors that influence their effective development and use. Understanding these factors can provide valuable insights into how to better support and encourage the adoption of interactive videos in graduate education, ultimately improving the teaching and learning experience.

Experimental Processes

The experimental process entails a sequential and methodical arrangement of actions, which are meticulously devised, executed, and evaluated with the purpose of addressing a research query or examining a hypothesis. As an essential component of the scientific method, it plays a crucial role in the advancement of scientific knowledge. This process encompasses many stages, including the identification of a research topic or hypothesis, the formulation of an experimental design, the implementation of the experiment, and the subsequent collection and interpretation of results. Laboratory studies play a crucial role in postgraduate education in facilitating the enhancement of students' skills, enabling them to provide answers for real-world issues, refining their scientific aptitude, and fostering their research capabilities (Fintschenko, 2011; Newstetter et al., 2010). When conducting experiments, it is imperative to address various factors. These include appropriately planning and designing the experiment, executing it under controlled conditions, ensuring the accuracy and reliability of data collection, and adhering to ethical guidelines throughout the process.

The outbreak of the Covid-19 pandemic and the subsequent shift towards remote learning have presented challenges in conducting experimental studies within higher education. The constraints on laboratory resources, equipment, and materials have posed significant obstacles to the execution of experimental work, a crucial component of graduate education. Virtual laboratories and simulations have been proposed as a viable alternative for offering students a learning experience when physical laboratories are unavailable (Radhamani et al., 2021). There is a need for further study and innovation in the field of distance education in order to address these problems and enhance the efficacy and engagement of experimental processes. This work incorporates an approach that involves the utilization of digital recording to document experimental processes conducted in graduate research studies. These recorded processes have been transformed afterwards into interactive videos, which are to be used in the context of teaching and learning.

The Role of Self-Efficacy, Motivation, and Intention in the Use of Technology

Self-efficacy, motivation and intention to use technology have long been shown important for the actual use of technology in education. Self-efficacy pertains to an individual's belief in his/her ability to effectively plan and carry out the steps required to accomplish a particular objective (Bandura, 1994; 1997). Individuals possessing high level of self-efficacy are inclined to establish clear objectives, control their exertion, efficiently manage their time, and engage in self-evaluation with more strategic intent (Bandura, 1997; Zimmerman, 2000). Hence, self-efficacy has been acknowledged as a pivotal factor in research related to the integration of technology (Albion, 1999). Hsia, Chang, and Tsang (2014) discovered that computer self-efficacy had notable direct influences on the perceived ease of using technology and the intention to use it. Moreover, as observed by Jiang and colleagues (2022), elevated levels of self-efficacy were closely associated with English teachers' inclination to adopt flipped teaching. Similarly, according to findings by Kumar and colleagues (2020), mobile learning self-efficacy had a positive and substantial impact on users' behavioral intention to embrace mobile learning. It is, therefore considered important to determine and find ways to support and improve individuals' self-efficacy to use technology.

Motivation to use technology has also been regarded a long-lasting critical factor in future use of technology. It is considered important for learners' self-regulation (Boakaerts, 2010; Pintrich, 1999; Pintrich & Zusho, 2002; Schunk & Zimmerman, 2004) due to being more attentive to learning processes (Bouffard-Bouchards et al, 1991), showing greater performance and satisfaction (Zimmerman & Kitsantas, 1999), putting increased effort (Schunk & Hanson, 1985), and being more persistent to learn on their own (Schunk, 1984). Self-efficacy is also regarded as a major source of motivation (Zimmerman & Schunk, 2008). Therefore, they all have an interconnected relationship. As such, intrinsic motivation is found to be an important factor for the behavioural intention for technology use for learning (Shroff & Keyes, 2017). Furthermore, it is associated with the satisfaction category of motivation, which is essential for maintaining desirable learning behaviours (Keller, 2016).

Methodology

A mixed method design including survey methodology combined with qualitative data collection has been utilized. The quantitative data collection was done pre- and post- training and the qualitative data were collected after the training. Data were collected from graduate students and instructors from various fields before and after face-to-face/online trainings on the design and use of interactive videos, which were conducted as part of a national project. Figure 1 shows sample views from trainings.

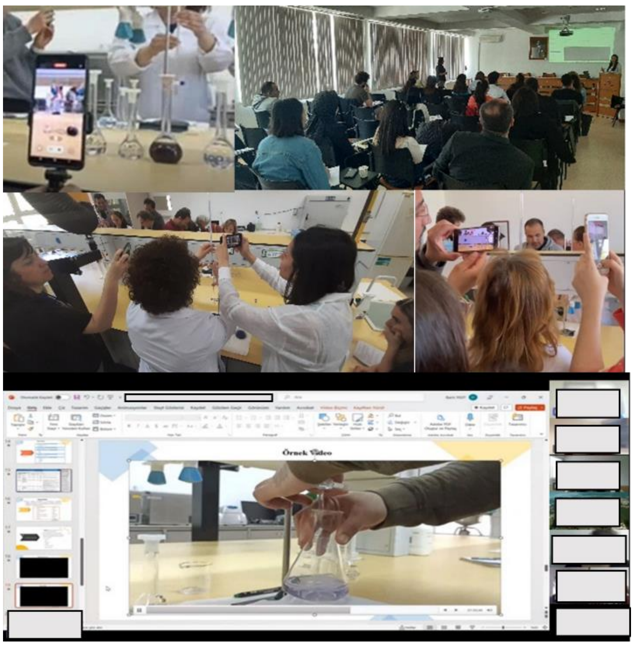

Fig. 1. Sample Views from Trainings

The questionnaires consisted of "General Information Form" including information such as gender, education level and field, previous experience of using videos and interactive videos, "Self-evaluation Form" including questions about self-efficacy in preparing and using videos and interactive videos, and "Opinions and Suggestions" sections consisting of open-ended questions about interactive videos and project evaluation. "Interactive Video Evaluation" form was added to the post-training questionnaire. In addition, the "Instructional Material Motivation Scale for Single-Use (IMMS-SU)" developed by Barut Tugtekin and Dursun (2022), which consists of 14 items, was applied to graduate students after the training. After face-to-face trainings, focus group interviews were conducted with 6 graduate students and 9 instructors to gather more in-depth data.

Ethical approval for the study was obtained on 01/09/2023 from the Ethics Committee of Eskişehir Technical University with the number 87914409-640-2300001361. Informed consent was obtained from all individual participants included in the study. It should be noted that since the participation in the training was voluntary, there may have been a self-selection bias. The different modalities of face-to-face and online learning may also have influenced participants' responses.

Data Collection Tools

Self-Efficacy Form

This form, which consists of questions about the participants' self-efficacy in preparing and using interactive videos, was developed by the researchers who have diverse academic backgrounds including engineering, education, and communication. In the process of creating this form, the relevant items in the "Guide to Preparing and Using Interactive Videos" (Gedik & Yiğit, 2023) that were developed for participants were utilized. As in the guide, the form consisted of three dimensions: pre-production process (PrePP), production process (PP) and post-production process (PostPP) of preparing interactive videos. The related self-efficacy statements were created based on the required competencies to be developed under these three headings. A dimension of usage process (UP) as an instructional material was also added to the form prepared for instructors. In order to ascertain the content validity of the form, consultations were held with an expert in the field of education and an expert in the field of measurement and evaluation in education.

Interactive Video Evaluation Form

During the training process, a six-item form using a 5-point Likert scale was prepared by the researchers for the participants to evaluate these interactive videos by showing them a sample interactive video and allowing them to use it. In this form, statements regarding the participants' perceived contribution of the interactive video in learning the experimental processes and their intention to use it in the future were included. The score of 1 denoted "Strongly Disagree" and 5 denoted "Strongly Agree".

Instructional Material Motivation Scale for Single-Use (IMMS-SU)

The IMMS-SU was developed and validated by Barut Tugtekin and Dursun (2022) in a two-phased process on a sample of 1654 students. The Exploratory Factor Analysis revealed that IMMS-SU included 14 items ($\chi 2 = 332.59$; sd = 74; $p < 0.001$), the fitness indices were found to be RMSEA = .077; SRMR = .040; AGFI = .88; NFI = .95; CFI = .96; and GFI = .92. The Cronbach's Alpha coefficients regarding the whole scale was calculated as $\alpha = 0.95$. This scale is specifically designed for students as it includes items related to their perceptions of learning. Consequently, it was not distributed to instructors, which underscores a potential limitation.

Semi Structured Interview Protocol

A semi-structured interview form was developed by the researchers including questions on interactive video development and use for graduate studies. Expert opinions were taken on the suitability of the questions and the form was improved accordingly. A total of nine questions were included in the form, which addressed participant experiences with the training, perceptions about the use of interactive videos for graduate laboratory experiments, the interactive features of sample interactive videos, and future intentions to design and develop interactive videos. Sample questions included the followings:

- What were your favourite parts of the training program? Why?
- What do you think about interactive videos?
  - What do you think about the preparation of interactive videos for graduate experiments?
  - Which interaction elements do you think are important (multiple choice question, open-ended question, fill-in-the-blank question, open-ended question, information text, information graphic, explanation text, pause/restart features, etc.)?
  - What do you think about the advantages and disadvantages of interactive videos?
- Would you consider preparing interactive videos for future processes? Why?

Participants and Setting

The questionnaire was completed by a total of 96 participants, comprising 42 graduate students and 54 instructors from diverse universities in Türkiye. Within this group, 18 graduate students and 17 instructors had participated in face-to-face trainings. The breakdown of participants by their fields of study is provided in Table 1. As illustrated in the table, a heterogeneous cohort comprising individuals with diverse academic fields has participated in the study. Additionally, nine instructors and six graduate students voluntarily took part in semi-structured interviews, which were conducted online.

Table 1. Information on Participants

Training Environment	**Participant Type**	**Number**	**Fields of Study**
Face-to-Face Training	Graduate Student	18	Engineering (12), Science (6)
	Instructor	17	Engineering (11), Science (4), Aeronautics (2), Sports (1)
Online workshop	Graduate Student	24	Engineering (9), Science (7), Health (5), Social Sciences (3)
	Instructor	37	Engineering (8), Science (9), Health (13), Social Sciences (7)
Total	Graduate Student	42	Engineering (21), Science (13), Health (5), Social Sciences (3)
	Instructor	54	Engineering (19), Science (13), Health (13), Social Sciences (7), Aeronautics (2), Sports (1)

Data Analysis

Data were analysed descriptively for the survey items on motivation and perceptions on the use of interactive videos for graduate experiments. For this aim, means, frequencies and percentages were calculated using SPSS version 20. For testing the effect of the training offered to graduate students and instructors on their interactive video development self-efficacy, it was investigated if there was a significant difference between the pre-test and post-test scores. For this aim, the normality of the difference scores was tested with the Shapiro-Wilk normality test. Considering the distribution of the data, the related sample t-test was performed for the data on students and the Wilcoxon Test for the instructors. For the interview data, the transcripts were gathered from the online videoconferencing platform and were checked for validity. The data were analysed based on specific themes of perceived advantages and intentions for future use. To do this, each response from the questions on the related theme was coded separately, assigned to segments, and then grouped into categories based on the related theme (Braun & Clarke, 2006). Related excerpts for each category were highlighted and interpreted together.

Findings

The Effect of Face-to-Face Training Provided to Graduate Students and Instructors on Interactive Video Preparation Self-Efficacy

Normality scores are shown in Table 2 for student data and Table 3 for instructor data. It was found that the distribution of the difference scores in all sub-dimensions was normal (p>.05) for the students' data. Considering the distribution of the student data, the related sample t-test was performed and the results of the test are given in Table 3. When Table 3 is examined, it is seen that there is a normal distribution for the PostPP and UP sub-dimensions, but a non-normal distribution for the PrePP and PP sub-dimensions. For this reason, the Wilcoxon signed-rank test was used for these sub-dimensions, and the related sample t-test was used for PostPP and UP. The results of the tests are given in Table 4 and Table 5.

Table 2. Normality Test Scores for Graduate Students' Data

Sub-Dimension	Test Score	d.f.	P
Pre-Production Process (PrePP)	.936	18	.252
Production Process (PP)	.977	18	.908
Post-Production Process (PostPP)	.919	18	.122

Table 3. Normality Test Scores for Instructors' Data

Sub-Dimension	Test Score	d.f.	P
Pre-Production Process (PrePP)	.885	16	.047*
Production Process (PP)	.867	16	.024*
Post-Production Process (PostPP)	.920	16	.167
Usage Process (UP)	.940	16	.349

When Table 4 is examined, it is seen that there is a significant difference between the pre-test and post-test scores of the graduate student data in all sub-dimensions. The difference in the pre-production dimension of t=-5.205 (p<.05), the production process dimension of t=-4.676 (p<.05) and the post-production dimension of t=-5.246 (p<.05) in favour of the post-test shows that the post-test scores of the participants were higher than the pre-test scores. This shows that the training received by the participants in the relevant sub-dimensions had increased their perceived self-efficacy. Cohen's d was calculated for effect size. Since the focus was on the change in difference scores, pre-test standard deviations were taken as suggested by Howell (2019). Accordingly, a significant increase between 1.22 and 1.27 standard deviations occurred after the training for all dimensions.

Table 4. Related Samples t-test Results on Graduate Students' Interactive Video Preparation Self-Efficacy Pretest-Posttest Scores

		Mean	SD	t	p	Cohen's d
Pair 1	PrePPpre – PrePPpost	-7.667	6.250	-5.205	.000*	1.220
Pair 2	PPpre - PPpost	-2.222	2.016	-4.676	.000*	1.236
Pair 3	PostPPpre – PostPPpost	-5.778	4.672	-5.246	.000*	1.270

*p<.05 significance level

When Table 5 is examined, it is seen that there is a significant difference between the pre-test and post-test scores of the instructors in the first and second sub-dimensions (p<.05). The difference in the pre-production dimension of z=-2.705 (p<.05) and the construction process dimension of z=-2.779 (p<.05) was in favour of the positive ranks- post-test, and the participants' post-test scores were higher than their pre-test scores was found to be high. This shows that the training received by the participants in the relevant sub-dimensions had increased their perceived self-efficacy. The r suggested by Rosenthal (1991) was used for the effect size. A medium-sized effect can be mentioned for the two sub-dimensions.

Table 5. Wilcoxon Signed-Rank Test Scores for Instructor Data

		N	Rank Average	Rank Sum	Z	p	Effect Size
PrePPpre - PrePPpost	Negative	3	3.17	9.50	-2.705	.007*	0.478
	Positive	11	8.68	95.50			
	Equal	2	-	-			
PPpre - PPpost	Negative	2	3.00	6.00	-2.779	.005*	0.491
	Positive	11	7.73	85.00			
	Equal	3	-	-			

*p<.05 significance level

When Table 6 is examined, it is seen that there is a significant difference between the pre-test and post-test scores of the students in the third and fourth sub-dimensions. The difference in the post-production dimension t=-3.662 (p<.05) and in the usage process as an instructional material dimension t=-2.406 (p<.05) was in favour of the post-test and the participants' post-test scores were higher than their pre-test scores. This shows that the training received by the participants in the relevant sub-dimensions had increased their perceived self-efficacy. When the effect sizes were analysed, an increase of approximately 1 standard deviation was found for the third dimension after the training, whereas a smaller effect size of 0.40 was obtained for the fourth dimension.

Table 6. Related Samples t-test Results of Instructors' Interactive Video Preparation Self-Efficacy

		Mean	SD	t	p	Cohen's d
Pair 3	PostPPpre - PostPPpost	-4.813	5.256	-3.662	.002*	1.042
Pair 4	UPpre – UPpost	-0.875	1.455	-2.406	.029*	0.405

*p<.05 significance level

Graduate Students' Motivations to Use Interactive Videos in Graduate Process

Table 7 shows the results of the students' motivation scores for interactive videos. The total mean score of the scale was found to be 4.44, denoting a high level of motivation to use interactive video use as an instructional material. Both face-to-face and online participants had high motivation scores. The highest scores were obtained for the items of "7. I believed that studying with this material would be beneficial to me" (M=4.67) and "4. I enjoyed studying with this material" (M=4.64). The lowest mean was for the item of "13. I spent less effort studying with this material" (M=4.14).

Table 7. Results on Graduate Students' Motivation on Using Interactive Videos

Instructional Material Motivation Scale for Single-Use (IMMS-SU)	Face-to-face participants (n=18)		Online participants (n=24)		Total	
	M	SD	M	SD	M	SD
1. I studied with this material easier than I expected.	4.33	.67	4.46	.82	4.41	.76
2. I remember more easily what I have studied with this material.	4.28	.65	4.42	.91	4.36	.81
3. There were features in this material that made me realize the crucial information.	4.39	.76	4.50	.82	4.45	.79
4. I enjoyed studying with this material.	4.67	.47	4.63	.63	4.64	.57
5. This material was intriguing.	4.61	.59	4.58	.64	4.60	.62
6. This material allowed me to focus on the topic.	4.39	.76	4.63	.76	4.52	.76
7. I believed that studying with this material would be beneficial to me.	4.78	.53	4.58	.64	4.67	.60
8. This material has increased my belief that I can be successful.	4.28	.87	4.63	.86	4.48	.88
9. I prefer to study with such materials on complex topics.	4.28	.99	4.38	.86	4.33	.92
10. This material contained interesting properties.	4.28	.87	4.54	.64	4.43	.76
11. This material increased my desire to study.	4.22	.79	4.54	.71	4.41	.76
12. I watched this material with pleasure to the end.	4.17	.76	4.50	.65	4.36	.72
13. I spent less effort studying with this material.	4.00	.94	4.25	.83	4.14	.89
14. It was exciting for me to study with this material.	4.28	.80	4.46	.71	4.38	.75
Total	4.35	.79	4.51	.76	4.44	.77

Student and Instructor Opinions on Using Interactive Video in Experimental Processes

Sample interactive videos were shared with all participants who attended the training and workshop, and after the training and workshop, the participants were asked their opinions on the potential use of interactive video in their graduate studies. As shown in Table 8, the participants had positive opinions. Negative opinions were only 2.4% for each item. The most positive opinions are seen in the statements "I would also like to prepare such an interactive video" (29.3% agree and 63.4% strongly agree) and "The interactive video shown can be helpful in teaching the experimental processes to students who will begin the experiments" (17.1% agree and 75.6% strongly agree). Although it was a positive opinion, the statement with less positive percentage was "The questions asked in the interactive video were remarkable" (2.4% disagree and 14.6% neither agree nor disagree).

Table 8. Student Opinions on Using Interactive Video in Experimental Processes

	Distribution (%)				
	1	**2**	**3**	**4**	**5**
1. The interactive video shown can help me learn about the experimental processes.	-	2.4	4.9	29.3	63.4
2. The interactive video shown can be helpful in teaching the experimental processes to students who will begin the experiments.	2.4	-	4.9	17.1	75.6
3. It would be helpful to prepare the interactive video format shown for our experiments as well.	-	2.4	7.3	29.3	61.0
4. I would also like to prepare such an interactive video.	-	2.4	4.9	17.1	75.6
5. The questions asked in the interactive video were remarkable.	-	2.4	14.6	36.6	46.3
6. The questions asked in the interactive video make it easier to learn the experimental process.	-	2.4	7.3	29.3	61.0

Similar to the student data, the instructors had positive opinions about the use of interactive videos in their graduate studies (Table 9). The most positive comments were "The interactive video shown can be helpful in teaching experimental processes to students who will begin the experiments" (22.2% agree and 63.0% strongly agree) and "It would be helpful to prepare the interactive video format shown for our experiments as well" (14.8% agree and 66.7% strongly agree). Although there was a high level of agreement (66.7%), the statement "The questions asked in the interactive video were remarkable" had the lowest level of agreement of all the items.

Table 9. Instructor Opinions on Using Interactive Videos in Experimental Processes

	Distribution (%)				
	1	**2**	**3**	**4**	**5**
1.The interactive video shown can help my students learn about the experimental processes in different projects.	-	1.9	9.3	22.2	61.1
2.The interactive video shown can be helpful in teaching the experimental processes to students who will begin the experiments.	-	-	9.3	22.2	63.0
3.It would be helpful to prepare the interactive video format shown for our experiments as well.	-	-	16.7	14.8	66.7
4.I would also like to prepare such an interactive video.	-	1.9	13.0	22.2	59.3
5.I would like my students to prepare such interactive videos.	-	3.7	13.0	20.4	59.3
6.The questions asked in the interactive video were remarkable.	-	7.4	20.4	24.1	42.6
7.The questions asked in the interactive video make it easier to learn the experimental process.	-	-	20.4	24.1	50.0
8.I recommend preparing interactive videos for projects in our field.	-	1.9	14.8	16.7	63.0

The Qualitative Findings

Perceived Advantages

All students and instructors made positive comments about pedagogical affordances and advantages of interactive videos for graduate studies. The basic rationale and driver for them were stated as “the need in graduate period” and “being an effective material in terms of multimedia and interaction features”. Sample excerpts are as the following:

> … we learn devices or methods by trial-and-error method. It's a waste of time and we spend time learning a (known) method rather than something new that you can find as a result of the work. That's why interactive videos and shares are so valuable. (Instructor K25, Questionnaire Data)
>
> … The responsible technician in the laboratory may not always be available and it is necessary to train the other person. However, we need to make sure that that person can use it in the laboratory, because if something happens to the device, it causes really big problems. So, we actually thought of making such an interactive video for devices so that we can use them safely and successfully. (Graduate Student K1, Interview Data)

There have also been responses focusing on “ease of preparation”, “learning from others’ projects” and “helping others to learn”. Sample excerpts are as the following:

> Frankly, I do not think the existing content explanations are effective. I don't think they are interesting, either. These kinds of events increase the interaction a little more: Video-assisted trainings. … Honestly, I learned how to design and develop interactive videos from a different perspective. I saw what I could do during my own video shoot. I also learned how to shoot correctly. At the same time, I have seen how effective learning can be provided in the editing part of which process (Graduate Student, Education, Interview Record, K5).
>
> I think the most difficult part of the experimental process is the beginning. It is very important to make sure that you know how to get started. I have experienced doubts about my knowledge during my experimental study. I think that the interactive video is an appropriate and easily accessible guide for my fellow researchers who will go through the same experimental process after me. (Graduate Student K21, Questionnaire Data)

One student also mentioned that it would be effective to use interactive videos in her graduate research presentations and project applications. The participants shared ideas that using interactive videos could be helpful not only during research processes but also teaching and learning processes.

Intentions to Use Interactive Videos in Future Graduate Studies

Both students and instructors indicated a willingness to utilize interactive videos in the future, citing their efficacy. However, several participants expressed reservations about the existing platform's limitations, particularly with regard to long-term publishing of interactive videos. Sample excerpts are as the following:

> I intend to use it [in the future]. The reason is that the interactive video is against non-attention, and I think it is very practical since when the student misses the part of the information, he/she can go back and look again when he/she gives the wrong answer to the question. (Graduate Student, K25, Questionnaire Data)
>
> I believe that it will also save time for researchers who will both record the experimental process and learn about it. For this reason, I would like to both reinforce my knowledge and help fellow researchers who will prepare the same experimental model by developing

> my future experimental studies as interactive videos. (Graduate Student K21, Questionnaire Data)
>
> I have just began working on microplastics and there is lack of established methodology in the field. Since many problems were encountered, I was thinking of trying a few different methods and recording them. It was an interactive video. I'm planning to include it in this and prepare a presentation like this for exams. So, I will include the presentation as well. In addition, I will record these interactive videos to use in their future work, and we are currently preparing a 1001 project to submit to TÜBİTAK, especially for that place where we can compare these methodologies, so I am thinking of making such a recording and preparing interactive videos. … We thought, in terms of transferring it to the next [graduate students]. (Graduate Student, Education, Interview Record, K8)
>
> Being both interactive and offering cognitive and visual support makes me feel intentioned to use them in future. (Instructor K11, Questionnaire Data)
>
> I definitely plan to use them in future. I believe that, it [using interactive videos] will create an effective learning environment for our students particularly for experiments having long learning time or ones having budget inadequacies for trial studies. (Instructor K3, Questionnaire Data)

One instructor (Instructor K14, Interview Data) also mentioned that recording an experimental process in the laboratory required a peer to work together and share the task. She explicated the argument as such: "*In other words, someone has to shoot while someone is doing it so that they can create a proper video*.". Several other instructors stated that undergraduate students can also be part of videos so that they could learn about the processes better.

Discussion and Conclusion

The results showed that the level of perceived self-efficacy of the participants increased after the training. During the training sessions, the participants were involved in laboratory video shootings and the development of interactive videos of their shootings. Although several participants had prior video shooting experience, the majority had no professional experience, and were reluctant to create videos of their research studies. The increased perceived self-efficacy can be considered an indication of participants' growing confidence and competence in creating and utilizing interactive videos as part of their graduate research endeavors. This shift in self-efficacy aligns with the established literature on self-regulated learning, motivation, and educational technology integration. This finding resonates with previous research emphasizing the importance of self-efficacy in influencing learners' motivation, performance, and persistence (Zimmerman & Kitsantas, 1999; Schunk & Zimmerman, 2008). Notably, as learners develop higher self-efficacy, they tend to exhibit more active engagement in the learning process, exert greater effort (Schunk & Hanson, 1985), and display increased perseverance in self-directed learning (Schunk, 1984). Moreover, the study contributes to the literature by demonstrating the interconnected relationship between self-efficacy and intrinsic motivation. It is evident that enhancing self-efficacy can positively influence intrinsic motivation and, in turn, the intention to adopt technology for learning.

The integration of interactive videos into graduate research holds promising implications. As the participants' self-efficacy in video creation and utilization improved, they reported positive perceptions regarding the contributions of interactive videos to their understanding of experimental processes. This aligns with the notion that interactive videos can serve as effective learning resources, enhancing the overall educational experience (Wachtler et al., 2016). The insights gained from the semi-structured interviews provide a rich source of qualitative data, offering a comprehensive view of the participants' experiences. The participants highlighted the availabilities of interactive videos as being responsive and effective resource that rescue from a trial-and-error approach in graduate experimental studies.

In terms of the motivation of the graduate students in using interactive videos, the results showed that the participants found the interactive videos to be a useful and enjoyable learning resource. They expressed motivation driven by the realization that studying with this material demanded less effort, a factor that can contribute significantly to their self-regulated learning experiences. This alignment between increased motivation and the perceived benefits of interactive videos supports the idea that enhanced self-efficacy can amplify learners' motivation and positively impact their intention to adopt technology for educational purposes. The study's findings thus emphasize the promising role of interactive videos in graduate research and learning, enhancing motivation and facilitating a more engaging and efficient learning experience for students. Moreover, the observed link between self-efficacy and motivation emphasizes the need for educational institutions and instructors to invest in training programs that empower students and educators to create and effectively utilize interactive videos. As Jiang et al. (2019) and Wiseman et al. (2018) stressed, use experience can improve the future intention of using technology. Also, by building self-efficacy in these skills, it is possible to boost motivation and self-directed learning, thereby enhancing the overall educational experience.

Expanding on these findings, the participants' perception of interactive videos as enjoyable and less effort-intensive materials is of particular significance. This perception aligns with the literature on motivation and self-regulated learning, as it suggests that the design and implementation of interactive videos can play a crucial role in fostering a positive and engaging learning environment. These findings highlight the potential for educators and instructional designers to leverage interactive videos to create educational experiences that are not only effective in conveying complex information but also enjoyable for learners, in line with related literature (Doğru et al., 2023). This positive user experience can, in turn, contribute to increased motivation and a higher likelihood of continued engagement with technology-enhanced learning resources. This sentiment is particularly evident in the responses of the participants' regarding their intention for future use. As suggested by participants, the presence of a peer in videos can to be effective for an individual's gains from video lectures (Pi et al., 2023). As such, graduate students shooting an experimental process with their presence can yield better learning outcomes for other graduate students. Furthermore, this can be also linked with undergraduate students, who can contribute to the process and eventually enhance their learning.

The latest developments in generative artificial intelligence have fuelled the opportunities for the development of videos (Chan & Hu, 2023) and also offered implications for research (Bates et al., 2020). Having the potential to easily generate and synthesize information (Berg, 2023; Chan & Zhou, 2023), the threats including ethics, plagiarism and more specifically biased or inaccurate dataset (Doğru, 2023; Feher, 2024; Harrer, 2023) lead to cautions. It is believed that real videos of research processes enriched with interactive elements can be strong evidence for the validity of research studies. Therefore, it can be argued that the use of interactive videos in experimental studies can lead to such evidences. Nonetheless, it is prudent to proceed with caution, as the process of content creation during video production is vulnerable to potential exacerbating and misinformation threats (Alsharif, 2024; Schoentgen & Wilkinson, 2021). In regard to content production, there is a genuine possibility of adverse consequences. For instance, artificial intelligence has the potential to alter the perception of both tangible and intangible entities, leading to the formation of reality illusions (Anantrasirichai & Bull, 2021). It is inevitable that the production of visual, audio, video, and text as synthetic content or synthetic media will continue to increase on a daily basis and occupy an ever-expanding space (Feher, 2024). Deepfake and artificial intelligence tools undoubtedly have the potential to cause significant and unfavorable consequences by presenting fabricated scenarios as reality (Dagar and Vishwakarma, 2022; Whittaker et al., 2020). While these technologies offer significant benefits, it is imperative that appropriate and effective sanctions are put in place to prevent or mitigate any potential negative consequences.

In conclusion, the study highlights the importance of self-efficacy and intrinsic motivation in the effective integration of interactive videos into graduate research and learning processes. It is therefore recommended that training and workshops be conducted for researchers, educators, and students from diverse fields to unlock the potential of interactive videos as valuable tools for improving understanding, engagement, and the overall educational and research experience in graduate studies. The research findings provide a foundation for the continued development and utilization of interactive videos in educational settings, offering a promising path toward enriching and extending graduate research and fostering self-regulated learning.

As mentioned in different parts of the study, there are certain limitations that may limit the generalizability of the results. First of all, this study is limited by the small sample size. The research context included higher education institutions with a limited number of disciplines from a developing country. In addition, the general aspects of interactive videos were considered due to the participants from different fields. Therefore, it is suggested that future studies be conducted with larger sample sizes from different disciplines and cultural settings and for longer periods of time, focusing on more detailed aspects of interactive videos.

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