Video Creation as a Catalyst of Value Change in Engineering Education

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***Abstract*— Today educational videos have become a significant element in enhancing teaching and learning. They represent an important learning value to promote knowledge creation and translation for in-class, blended, and online learning. Effective creation and sharing of videos are enriched when instructors consider several principles: how to promote digital literacy in the class environment; how to maximize student engagement in making and sharing videos; how a video can make a tangible difference in the education landscape, and how to utilize this process to promote value creation in education? This article reviews literature relevant to each of these principles and presents a case of making educational videos in the context of value creation in teaching ethical professional practice in engineering and computing. The case advocates several feasible approaches instructors may embrace to assimilate knowledge creation, digital engagement, critical thinking, and growth mindset that allow students to take ownership of their learning.**

***Index Terms*—Video creation, reflection practice, knowledge creation, active learning, flipped classroom, digital literacy, value change.**

I. INTRODUCTION

Teachers know that their students have different learning styles depending on their life and needs. These may include learning by seeing and hearing, reflecting critically and culturally, reasoning logically and intuitively, memorizing and visualizing, drawing analogies, and building mathematical models [1-3]. All the above styles promote interest and open minds in classrooms, however learning through reflection is a practice of engagement that empowers learners to explore, examine, and realize their feeling and reasoning [4] as well as the value of their learning.

Sfard [5] labeled the "acquisition" metaphor for learning as something which results in the personal acquisition of knowledge and a well-rounded skill set, much like possessing an object. This metaphor is a conventional way of thinking about learning in many educational institutions, in particular, where knowledge is transferred from teacher to student. In this regard, attention may be paid to other concepts of learning, including "learning as participation" or "learning as knowledge creation". For example, if learning is realized as a matter of attaining content only, then tools should be available for students to acquire that content. However, if learning is perceived as a matter of participating in a practice, tools are there to be grasped, as mechanisms of that practice [6]. On the other hand, if the process of learning is understood as an idea of collaboration in knowledge creation, new methodologies may be designed mostly by teachers who should evolve into resourceful educational leaders within an active learning environment.

The infusion of information and communication technologies (ICT) in education is a primary driver behind active learning. Engineering as an inherently collaborative field responded to the explosion in knowledge by incessantly developing new learning tools. As more of these tools evolve, the challenges of the new learning environment intensify. What makes this particularly important today is the range of opportunities that digital transformation provides for creating new kinds of learning activities and experiences. The question is in identifying the right tools and using them intelligently. To create a competitive advantage, learners should be enabled to establish an innovative environment of knowledge collection and creation through digital engagement. A successful environment provides the learners both a chance to reach their potential as learners and the opportunity to engage in beyond pure technical activities that they may benefit from after graduation.

Engaging in learning entails effective content, knowledge-sharing platforms, services, tools, tasks, and assessment strategies. In education, knowledge creation and translation pedagogies have not been completely applied to various learning settings [1]. As education is becoming more competitive, digital transformation is turning into a necessary instrument of endurance as the new digital world requires educators to adapt and adopt digital mindsets and pedagogies. Capabilities such as simulation, animation, and visualization offer new alternative concepts in teaching by embedding ubiquitous learning into flipped or inverted classroom approach [7] to deliver experiences to users at anytime, anywhere, and anyway, mostly with individualized guidance. This may mean delivering the content outside the classroom and keeping learning activities in the classroom. The phenomenon of a "flipped classroom" combined with digital transformation may be considered a promoter for change within the typical learning (in-class and/or hybrid) environment.

The process of using educational videos as a learning experience has a long tradition in education, but its functionality has radically changed in the last few years. What was like a lot of work in the past, is nowadays feasible for every educator with suitable software [8]. Web 2:0 technologies, including minimally edited videos, have multiplied the number of participants in the production of knowledge, and they greatly extend the reach and circulation of digital objects, video, sound clips, text, graphics, and so forth [9].

Today, very little is known about the production of educational videos and their role in knowledge creation. This is identified as a major gap in the research that requires more

investigation. That being said, how do the roles of instructors and learners evolve and overlap as the learning environment moves beyond a focus on passively watching videos to actively making and sharing them?

This article explores the above research question by introducing a methodology in knowledge creation to make and share educational videos as a changing pedagogy on reflective practice and redesign of learning responsibilities within an active learning environment. It presents a case of teaching a course on ethical professional practice in engineering and computing. This methodology recommends creating project educational videos among other activities like research cases and technical articles, which instructors may adopt to develop a growth mindset that integrates knowledge creation, digital engagement, and critical thinking to enhance learners' well-rounded skill sets and advance their careers.

II. Knowledge Creation and Active Learning

Knowledge creation denotes the process of generating new ideas or insights through exploration. On the other hand, active learning is a student-centered pedagogy that involves engagement and collaboration. Both concepts are intertwined and vital for critical thinking skills as well as creativity and innovation.

Today, the amount of knowledge that students need to acquire and understand is increasing faster than the ability of curricula to include it or the students to learn it just by attending classes, memorizing content, and writing exams [1]. To understand, students need to think about what they learn, reflect on their past experiences, and apply it to what they think is valuable and probably part of themselves [10]. This reality demands reconsidering a learner-centered pedagogy by moving from the possession of knowledge to the creation and translation of knowledge, which comes about through reflection and engagement in an active learning environment.

Active learning is an instructional strategy that involves students in the learning process beyond listening and passive note-taking. It develops skills and higher-order thinking through activities that might include reading, writing, and discussion [12], but goes beyond the classroom to "learning by doing". It guides better performance in tasks beyond the passive mode of classroom lectures. It involves maximizing opportunities for students to experiment and collaborate. However, using active learning strategies does not require abandoning lecturing. Instead, including activities may make lecturing more relevant to student learning especially when teaching about an invisible phenomenon, where a design and simulation become essential [13, 14].

In knowledge creation, there are two dimensions to consider: epistemological (tacit and explicit knowledge) and ontological (knowledge creation at the individual, group, and organizational levels) [1, 15]. Tacit knowledge implies ideas and hands-on skills that are hard to articulate because they are learned largely through experience (know-how), competence, and dedication. However, explicit knowledge refers to information that is easy to articulate, write down, and share such as clear-cut facts (know-what) including books, software, and videos. Learning, in general, has both a tacit and an explicit dimension [1, 16]. This four-dimensional structure is understood as a catalyst of disruptive innovation or proactive educational pedagogy to change the learning process.

Another important notion for the active learning environment is knowledge translation. It is a relatively new term, first proposed by the Canadian Institute of Health Research (CIHR). It is an active multistep process that is focused on associating the "know-how-what-do gap" between knowledge creation and its implementation [17]. To develop a successful knowledge-translation approach, it is needed to understand how different types of knowledge are communicated, developed, and disseminated.

After all, teaching that encourages active learning invites learners to make or produce something, which may serve to facilitate and evaluate their understanding [18]. Therefore, students learn more effectively when they are vigorously involved in creating and translating their knowledge [19], the process that fosters innovation.

III. Video-based Learning (VBL)

VBL has become a conduit for a more interactive learning experience than just the provision of information. This involves the action of doing; it is about thinking while doing. Schon [20] terms this activity "reflection-in-action" and encourages students to learn "a kind of reflection-in-action that goes beyond statable rules". He suggests two modes of action: telling and listening; demonstrating and imitating. The first mode is typical in engineering education, while the second mode requires the instructor to reveal how to design something followed by simulation by the student. This entails the collaboration of the instructor and students in solving open-ended problems that are new to both of them.

Regardless of modality, blending videos with active learning strategies encourages students to create and view videos and make connections between new concepts and prior knowledge. Video design and creation may also help instructors maximize their effectiveness in the classroom by considering three components: cognitive load, student engagement, and active learning [21].

One of the primary considerations when developing educational videos is cognitive load. Cognitive load theory, initially articulated by John Sweller [21], implies that memory has several elements including sensory, working, and long-term. Sensory memory is temporary, gathering information from the environment to be chosen for temporary storage and processing in working memory. This process is a requirement for training in the long-term memory.

Although VBL is still top-down and teacher-centered [22], there is still an increasing inclination toward linking both teacher-centered and learner-centered pedagogies [23]. This occurs when students make videos rather than just view videos in addition to sharing the videos they produce with others. Figure 1 shows the transition from the old pedagogy where the teacher is the only source of knowledge to the learner-centered pedagogy where the teacher plays the role of facilitator [11]. This involves shifting the focus from the teacher who is the authority figure and the source of knowledge to the students who are the active participants in their learning environment. Accordingly, VBL as a process of making and sharing videos represents one of the vehicle of migration from the old pedagogy to the new one. However, both pedagogies have their place in education.

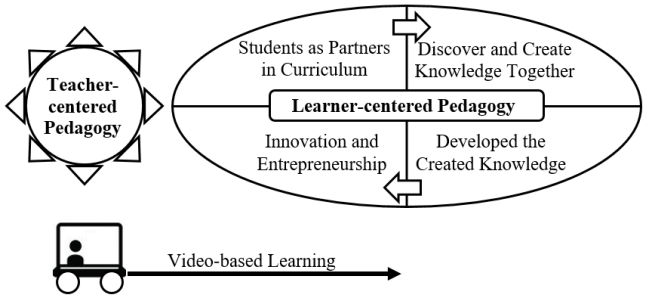

Figure 1. The transition from old pedagogy to new pedagogy.

Today, videos are valuable in many blended and online courses, but ensuring that videos can help student learning involves taking a greater look at video design and production. Creating video content may be an effective way to assist students in their learning. The key is, to begin with, reliable instructional objectives and following a good plan on the storyboard to insure the core message is presented and have the students effectively engaged. A script for the educational video will help shorten and organize its content. To keep the attention during watching, the use of signaling [24] is advised. This may be realized with arrows that point to a specific location on the screen or with colors, which highpoint the part of the figure or the picture that is being clarified.

To understand how people learn with videos, it is essential to think of the principle of multimedia learning as shown in Figure 2. This affirms that humans learn more deeply from a pattern of words and pictures (illustrations, photos, animation, and video) than from words only. Multimedia training is therefore outlined as "presenting words and pictures that are intended to advance learning" [25]. However, this requires prior knowledge that is gained independently of an experience as a result of abstract or logical reasoning alone.

The most important result of learning with digital means (ubiquitous) is that learning with a combination of text and pictures is more effective than learning with just a text. This supports the flipped classroom approach which consists of two distinct parts: direct online instruction at the student's own time and pace, and interactive group learning activities in scheduled classes [26]. This combination is critical for developing a growth mindset that inspires cognitive learning, seeks out new challenges, increases access to practical explanations, and importantly flips learning spaces: the prospect of flexible learning anywhere at any time.

IV. Knowledge-sharing Platforms

Knowledge-sharing platforms are online services and tools that offer a variety of educational resources and allow students to share information and knowledge with individuals, groups, and communities. These platforms may exist in different forms including blogs, social media, learning resources, and podcasts.

An engaging platform like Brightspace is an excellent learning management system for communities like colleges and universities. It provides a range of features and tools for the creation and delivery of digital content and activities. It is effectively employed for teaching the course under consideration in this article. Brightspace analytics tools may be used to monitor student engagement with the video content.

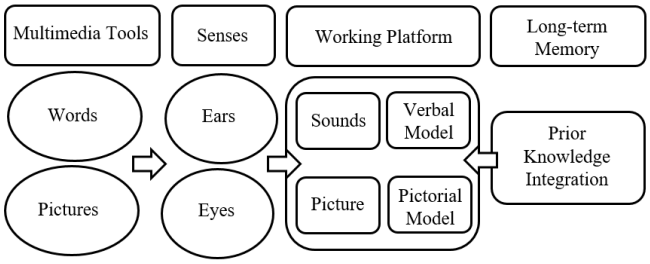

Figure 2. Cognitive theory of multimedia learning.

For students, the free video streaming platform YouTube and Vimeo are the most popular on the web with many channels dedicated to various topics. They offer a range of high-quality features and customization options for video creators within many different genres that exist across diverse art forms.

Another reinforcing platform to facilitate access to information and knowledge creation is the establishment of open educational resources (OER). The OER definition is coined by UNESCO [27] as an "open provision of educational resources, enabled by pervasive ICT, for consultation, use, and adaptation by a community of users for noncommercial purposes." To accomplish the above goal, an OER, namely "g9toengineering.com" was developed by the first author in 2007 to support teaching several engineering courses and to provide open access to knowledge creation in several topics [28]. This OER contains a set of activities and learner-generated content around the creation and sharing of knowledge. The main objective of the OER is to provide a wide range of learners with open access to educational resources and content.

V. Case of Teaching Ethical Professional Practice

As a continuing process of developing activities for educational reflective practice, a systematic process for knowledge creation and translation was formed several years ago for a high-enrollment undergraduate course, "Professional Practice in Engineering and Computing". To achieve the goal, case-based learning (CBL), project-based learning (PBL), and VBL are usually implemented in teaching the course while the instructor acts as a facilitator in the learning process. The aim is to teach the course material on a "need to know" basis where the class is flipped into a community of learning and practice, researching and gathering knowledge, then deciding from among the best solutions. CBL, PBL, and VBL employ the 4Cs principle: critical thinking, communication, collaboration, and creativity, with outcomes tied to learning goals.

The course learning components are divided into four categories namely multiple-choice question-based midterm and the final exam, four research case studies, and a project of three tasks. The 10-week case studies and project are carried out in groups of two students, each based on authentic open-ended real-world problems with clear instructions. The topics as a whole make the experience worthy of reflection. The case studies present students with ethical situations that

involve the application of their knowledge to decide what they know that is relevant to the cases, what other information they may require to obtain, and what impacts their decision may have. Topics include professionalism, ethics and equity in engineering, intrapreneurial mindset, and ChatGPT ethicality. The case narratives are accompanied by supporting information and tools that facilitate knowledge creation including the course reference book [29] and various research articles. For each case, the students develop an "e-Portfolio" that includes the investigation details and a summary of the results. The e-Portfolio reflects the student's advancement in a self-directed knowledge translation approach with a cumulative "e-Poster" to propagate outcomes.

A list of project topics with clear research questions was given to the students for investigation. Among the topics are the ethical practice of robotics, artificial intelligence, self-driven vehicles, Internet-of-Things (IoT), 5G technologies, technology in classrooms, virtual reality, and sustainability. Students are also given the option to pick up their topic ideas. These ideas are collaborative tasks that are largely based on the triangular concept of "values", "ethics", and "morals" as shown in Figure 3. Values represent the principles, models, and standards, which may help in making the judgment of what is important in life. Ethics refers to the guidelines for conduct that address questions about morals. Morals are the system of beliefs that emerge out of core values and ethics. The course project involves three tasks including a proposal, a two-minute educational video, and an article. The above three project activities reflect the entire tasks of the project.

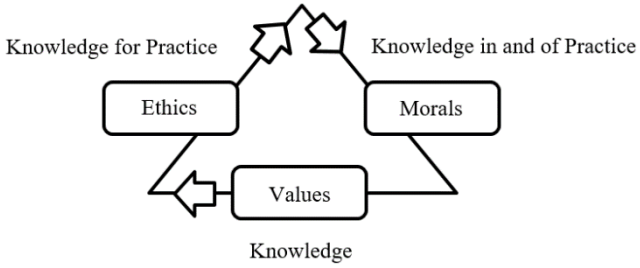

Figure 3. The triangularity of values, ethics, and morals.

The educational videos combine reflection on what students have learned; deliberately analyze decision-making, depict knowledge content, and connect it to what they do and learn in the classroom. Undoubtedly the key idea on how to use videos in education is the learning by design methodology. In this process, students are active designers of the learning content. They write storyboards in a team, look for pertinent materials, and produce their videos artistically.

VI. Assessment and Student Experience

The course under consideration is taught with the goal of knowledge creation in mind. The use of videos in education is usually associated with challenges where all students watch the produced videos together in class and/or online while individual learning pace or prior knowledge should be integrated to enhance reflection on the learning content. At the end of the semester, several video presentation sessions were organized. The class 192 groups were invited to watch their videos together in several sessions. This is the step in which the outcomes of learning are exchanged where students and teachers interact together by watching videos and realizing the newly created knowledge.

VBL may be an effective tool for assessing learning outcomes, however, the great challenge for the instructor is how to evaluate the videos within the content and cognitive context in mind. Before viewing the videos, the instructor and teaching assistant made a series of subjective ratings: judgment of learning, presentation style, engagement, and interest rating. Videos were marked on a scale of 0 to 10. The top five videos were selected for an award.

For the online anonymous survey, the instructor thought of four specific questions about the effectiveness of the course learning tasks including the four case studies, project, and multiple-choice questions-based midterm and final exam. Students' satisfaction concerning the course learning components and results was measured by analyzing the data collected from Questions 1 to 4 (Table 1). The data from Question 1 of the survey shows that most of the students support learner-centered (research cases and project) over teacher-based (midterm and final exam) pedagogy. In particular, data from Question 4 indicates that about 83% of students "strongly agreed and/or agreed" with the video creation exercise. Despite the satisfaction, this process might involve student uneasiness by being responsible for their learning tasks.

An important aspect of the assessment outcome is student fulfillment, which is correlated to but different from success as verified by student feedback and opinion about the video-making experience:

"*I believe the creation of educational videos has a large impact on the learning objectives of students. While working on this project video, I learned much more about my topic and was able to condense it in a way my peers could understand. It informally improved my speaking skills and allowed me to connect with the audience, like a YouTube video."*

"*When showing my friends, the video, they easily understood my research questions and became interested in the subject. Overall, I think letting students make videos in an ethics class is great as it aids the creator in learning and allows students to become aware of issues around them in an engaging manner. Personally, creating the project video was the best aspect of the project as it allowed me to showcase my creative skills and combine them in a way to educate others on a topic I am very interested in*."

According to the student feedback, it is obvious that teachers have an opening to increasingly motivate their students to influence their perception of learning.

A significant driver to pioneer the application of educational videos for student engagement is by making them. The idea is straightforward: if students do not make videos, they cannot learn simply by passively watching them. Engaging students to digitally reflect on a project task yields deeper levels of knowledge. Because students were working on different project tasks, they cannot all be expected to discover the same knowledge; however, each student possesses something unique from this engaging experience. One major takeout is to keep videos brief and targeted at learning goals as well as avoiding an in-person presentation style. The length of the video is a key factor to keep students

watching until the end. To deepen engagement and maximize learning outcomes, the top five videos were awarded a bonus of five marks in addition to the complete graded marks.

TABLE 1 Course anonymous survey outcomes

Survey Questions	**Student Response**			
I learnt for future practice from the course content overall, however, I enjoyed working on	Cases 63.77%	Project 57.97%	Midterm 21.74%	Final Exam 20.29%
Among the four given assignments, I enjoyed working on	Case 1 53.62%	Case 2 43.48%	Case 3 49.28%	Case 4 33.33%
I learnt for future practice from the course project, however, I enjoyed in particular	Proposal 27.54%	Debate 49.28%	Article 26.09%	Video 47.83
Videos improve students' understanding of difficult concepts when compared with a course where the videos are not used in conjunction with the project	Strongly agree 42.03%	Agree 40.58%	Neutral 13.04%	Disagree 4.35%

VII. Reflection Practice and Value Creation

In education, reflective practice plays a crucial role in value creation when learners acquire knowledge and skill set that apply to their lives [1]. The whole process is about learners' participation in a continual cycle of self-observation and self-evaluation to realize their actions and the reactions they stimulate in themselves. To effectively recognize this value, several changes in the education system should take place where classes will be more open to different learning experiences and teachers will continue as facilitators and organizers of services and tools [30]. However, this break from the traditional system is not without dispute. Students often may be uninterested to leave their comfort zone if they do not assure ownership or see the value that deserves more effort.

Initially, the teaching experience under consideration has specifically centered on exploring the flipped class practice, and instructional video production to adapt content to forthcoming learners. It exposes students to the pace of change by bringing research, professional practice, and teaching cultures close together while continuing to place the students at the heart of the learning process. In addition, it increases the usage of digital technology to reshape and reinvent the active learning model to shift to a more learner-centered experience that is suitable for large cohorts of students.

In the case under consideration, educational videos are used as an integral part of the learning activities provided in teaching ethical professional practice particularly when they are part of an engaging task like the course project. As an outcome of the survey and observation, students valued the videos and post-video discussions as though they were resourceful in promoting student understanding. It was found that students value the process of making and sharing the videos as a promotor for improving the deeper realization of complex concepts when compared to a course without video making. Student feedback and data indicate that integrating engaging activities with digital media where students receive traditional teaching and VBL combined may considerably improve student analytical thinking and reflective judgment.

The pervasive ICT, simulation tools and cloud capacity can promote student understanding and help articulate several key lessons taught by the experience under consideration. It also assists educators to facilitate reflection on learning practices by creating and translating knowledge more effectively.

Re-thinking and re-designing course content in response to the existing digital transformation for students who have different learning experiences and expectations may in itself have a substantial impact on improving teaching. Changing learning away from knowledge possession toward knowledge creation involves thorough consideration of the students as learners. Because the effectiveness of an approach lies in transformative learning outcomes. The focus should shift toward keynote lectures, research tasks, interaction in the classroom, new assessment strategies, and rewards. Further, instructors that wish to provide effective transformative learning environments may create a structure of incentives and motivation that encourage students to put in the efforts needed. As the learning journey continues, the above experience may promote a powerful catalyst of value creation in education to bear in mind.

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