VOLUMETRIC ASSESSMENT OF PULMONARY ARTERY THROMBUS BURDEN

FACTORS INFLUENCING THE ADOPTION OF TECHNOLOGY IN TEACHING

A Thesis Prospectus
In STS 4500
Presented to
The Faculty of the
School of Engineering and Applied Science
University of Virginia
In Partial Fulfillment of the Requirements for the Degree
Bachelor of Science in Biomedical Engineering

By
Rohey Colley

October 27, 2023

Technical Project Team Members:

Yeongju Lee, Nyota Patel

On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

ADVISORS

Rider Foley, Department of Engineering and Society

Luke Wilkins, Department of Radiology and Medical Imaging

Introduction

The inspiration for this project is deeply personal, stemming from a harrowing event in 2006. After the birth of my brother, my mother faced a life-threatening pulmonary embolism (PE), enduring three harrowing days in the ICU. The gravity of the situation became real when physicians, bracing for the worst, asked if there was someone who could care for her children in her absence. That chilling moment ignited a deep determination within me. Aware that my mother's experience is shared by many, I am committed to this project as a personal crusade to pioneer improved medical responses for PE, aspiring to alter the narrative for numerous patients from despair to hope and restoration.

Pulmonary embolism arises from blood clots that typically form in the deep veins of the legs or pelvis, traveling through the bloodstream to lodge in the pulmonary arteries, the vessels that transport blood from the heart to the lungs (NHLB, NIH, 2022). These obstructions can severely impede pulmonary circulation, potentially diminishing the oxygen supply to vital organs and tissues (Radiology (ACR), 2022). Such clots often result from damaged veins due to surgical procedures, traumatic injuries, or inflammation from injections or wounds (NHLBI, NIH, 2022). As these embolisms can result in the sudden blockage of critical pulmonary arteries, PEs pose an immediate and significant risk to life (Cedars-Sinai, 2022).

PE stands as a major public health concern, accounting for an estimated 100,000 to 200,000 U.S. deaths every year (Tarbox & Swaroop, 2013). This alarming statistic underscores its position as the third leading cause of cardiovascular-related fatalities (Tarbox & Swaroop, 2013). The danger of PE is further magnified when it culminates in hemodynamic instability. In this state, the cardiovascular system, due to the embolic obstruction, becomes inadequate in supporting the body's metabolic needs (Pérez-Nieto et al., 2023). Such a dire situation often prompts clinicians to opt for therapeutic interventions like catheter-directed thrombectomy, a specialized procedure devised to meticulously extract the obstructing clot (Chandra et al., 2022).

However, the medical community faces a pivotal challenge: effectively determining if the removal or sufficient reduction of the thrombus has been achieved to restore adequate circulation (Liu et al., 2022). One proposed solution entails a comparison between the volume of the thrombus burden retrieved directly from the thrombectomy versus the volume derived by analyzing the difference in thrombus burden using (CT) scans taken before and after the thrombectomy. Yet, there persists a significant limitation in this approach — the current absence of a robust, automated method to quantify thrombus volume with CT imaging datasets (Wei et al., 2021). In collaboration with a Siemens representative, we aim to spearhead the development of an automated image segmentation technique tailored for CT datasets. Once synthesized into a comprehensive 3D model, this advanced method will then measure, with unparalleled precision, the volume of thrombus burden within the intricate network of pulmonary arteries and compare it to the post-operative condition.

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In current medical imaging practices, while the amount of thrombus retrieved post-procedure serves as a tangible metric, comparing it against the difference in volume before and after the thrombectomy, as visualized on CT scans, offers a comprehensive insight into the thrombectomy's success (Nosher et al., 2017). This comparative analysis not only helps identify more specific clinical endpoints, as many current studies describe them in broad terms, but also aids in tailoring future interventions based on individual patient responses (McLeod et al., 2019).

Yet, today's medical imaging is confronted with the challenges wrought by the absence of an automated technique to measure the volume of thrombus burden on a CT imaging data set.

Current methodologies require a trained professional to manually trace the boundaries of anatomical or pathological structures of interest (Liu et al., 2022). However, not only is this approach labor-intensive and time-consuming, but it also introduces the potential for human error (Adduru et al., 2020). This variability in interpretation, driven by subjectivity, can have cascading consequences on therapeutic decisions and patient outcomes (Chandra et al., 2022). Ideally, a clinician should have at their disposal a tool that seamlessly segments the thrombus from the surrounding anatomy on a CT scan, quantifies its volume, and presents this data in a digestible format, none of which necessitates human intervention. Such a tool would not only standardize the evaluation process across different medical personnel, but also expedite the decision-making process in critical scenarios (Root et al., 2017).

Considering these unmet needs, this project seeks to bridge the current technological gap. Our primary objective is to devise a method that facilitates automatic image segmentation within CT data sets. By employing sophisticated algorithms, harnessing the power of artificial intelligence and machine learning, we aim to differentiate and isolate the thrombus burden from other anatomical structures within the pulmonary arteries. This precision in segmentation is paramount, given the intricate nature of pulmonary vasculature and the diverse presentation of thrombi (Liu et al., 2022).

But segmentation alone does not suffice. Once isolated, the program should be adept at calculating the volume of the thrombus, providing quantitative data that can be juxtaposed against post-intervention results. This quantification would serve as a robust benchmark, enabling clinicians to assess the success of thrombectomy procedures and adjust their approach in real-time, if necessary.

To ensure the widespread applicability and integration of this tool, our vision extends beyond just developing an algorithm. We aspire to craft a stand-alone program in Python, one that seamlessly integrates with existing imaging systems, particularly those by Siemens. Such an integration would mean that all clinicians, regardless of their familiarity with advanced computational tools, could harness this technology, making it an indispensable part of the PE therapeutic toolbox. In bridging the realm of clinical radiology with advanced automation, we aim to revolutionize patient care and relieve the intense demands placed upon medical professionals, particularly radiologists. This integration exemplifies the broader trend of assimilating technology into various fields.

TECHNOLOGY, PEDAGOGY, AND CONTENT KNOWLEDGE (TPACK) FRAMEWORK AND ITS ROLE IN UNDERSTANDING THE ADOPTION OF TECHNOLOGY IN TEACHING

Just as in medicine, education has seen a notable shift towards technological incorporation, largely due to the indispensable role of digital technology during the COVID-19 pandemic (Haleem et al., 2022). As educational institutions in the U.S. grapple with the dynamics of incorporating technology into their curriculums, it becomes imperative to explore the underlying factors that influence such decisions. How do educators, IT coordinators, and administrative bodies perceive the role of technology in enhancing the teaching-learning process? What are the barriers and enablers to its seamless integration? The adoption of technology in teaching is an intricate process, influenced by a myriad of interconnected factors. Utilizing the TPACK framework, this analysis offers a comprehensive lens to the synergy between technological, pedagogical, and content knowledge, enabling one to understand the complex negotiations and interactions that culminate in the embedding of technology in the educational realm.

Central to the TPACK framework is the notion that effective teaching requires an understanding and integration of technology with pedagogy and content knowledge. For technology to be incorporated effectively into teaching, educators must align these components in a manner that enhances the learning experience. The willingness of teachers to adopt new technology, pivotal to this alignment, is often determined by their perceived ease of use and its potential benefits for pedagogical outcomes (Joo et al., 2018). If technology is deemed too cumbersome or misaligned with teaching objectives, its incorporation may be resisted (Sugar et al., 2004). Teachers' prior experiences, skills, and confidence with technology also play a significant role in their receptivity and ability to integrate these elements (Sugar et al., 2004).

Educational institutions also play a critical role in this framework, capable of either promoting or inhibiting technological adoption. The provision of training, resources, and continuous support, as emphasized within the TPACK framework, can alleviate teachers' apprehensions and encourage a culture of innovation (Joo et al., 2018). Conversely, a lack of vision or infrastructure can prevent even the most tech-savvy educators from effectively integrating technology (Joo et al., 2018). This is supported by research from Sugar, Crawley, and Fine, which examined teachers' decision-making about technology. Their findings suggest that educators' individual attitudes and the institutional support they receive significantly influence technology adoption, highlighting the need for administrators to address teachers' perceptions and provide tailored resources (Sugar et al., 2004).

The technological tools themselves, while not agents within TPACK, are nonetheless vital components. Their design, functionality, and interface must be considered in the context of how they support or hinder pedagogical goals and content delivery. Technologies that seamlessly integrate with existing educational practices tend to be more readily adopted, while those requiring significant changes to teaching methods may face resistance (Buabeng-Andoh, 2012). For instance, in a 2005 census on ICT infrastructure conducted by the National Council for Technology in Education in Ireland, it was ascertained that approximately 85.3% of schools experienced significant disruptions to learning time, attributing this to extensive periods spent addressing hardware and software issues (Buabeng-Andoh, 2012). This lends support to the notion that technologies which integrate seamlessly with existing systems and pedagogical methods will garner greater acceptance, in contrast to those necessitating significant shifts in teaching practices.

For technology to be firmly rooted in teaching, the TPACK framework implies a need for continuous professional development and a deep understanding of how technology can be harmonized with pedagogical objectives and subject content. Rather than a linear adoption process, TPACK reveals the nuanced interaction of knowledge domains, challenging educators to create a harmonious blend of technology, pedagogy, and content that evolves with the educational landscape in the digital age.

RESEARCH QUESTION AND METHOD

While technology holds the potential to transform traditional pedagogies, making learning more interactive and personalized, its adoption is not universal. Its integration is not a mere exchange of replacing traditional tools with digital ones, but rather a complex decision-making process influenced by a web of interconnected factors. This brings me to the central research inquiry: What are the factors influencing the adoption of technology in teaching?

At the heart of this question lies a matrix of socio-cultural, economic, personal, and institutional variables. For some educators, the personal motivation to enhance student engagement and learning outcomes might be the driving force behind technological assimilation (Akram et al., 2022). Others might feel the external pressure from institutional mandates or the broader educational community's shifting norms (Akram et al., 2022). Economic considerations, too, play a pivotal role, as technology requires investment, not just in the tools themselves but also in training and maintenance (Anderson & Becker, 2001).

The research will adopt a mixed-method approach, combining qualitative interviews and observational studies to delve deeply into the factors influencing the adoption of technology in teaching within both public and private schools. This focus is particularly driven by the notable disparity in technological utilization I observed during my transition from public to private education. The study will focus on two primary sites: the private school I attended, *Stone Ridge School of the Sacred Heart*, and the district-assigned public school I would have attended, *Gaithersburg High School*. The institutions are located in Bethesda and Gaithersburg, respectively, both cities within Montgomery County, Maryland. For the purpose of observation, I will partake in multiple class sessions to examine the fusion of technology within instructional methodologies. On the other hand, the qualitative interviews will include a range of participants, encompassing school administrators, IT coordinators, and educators from varied grade levels and disciplines. The inquiries I plan to present to these groups include: How do you perceive the balance between conventional instructional techniques and the assimilation of contemporary technological apparatuses in the educational setting? Based on your expertise, which technological instruments or platforms have proven most advantageous in advancing teaching? Moreover, what tactics do you adopt to ensure that both instructional personnel and students are adequately equipped and trained to harness the potential of digital educational resources? Upon collecting the data, I will transcribe all responses verbatim. Using manual coding software, I will then categorize the responses into themes to identify patterns and variations between the two school types as a means to inform my research.

CONCLUSION

In recent times, medical imaging faces challenges in effectively quantifying thrombus burden due to manual procedures that are error-prone and time-intensive. Addressing this, our project aspires to create an automated tool, employing artificial intelligence and machine learning, to precisely segment and measure thrombus volume in CT scans, promoting consistency and rapid decision-making in clinical scenarios. Collaborative efforts with technology companies, namely Siemens, aim to ensure the tool's integration with existing systems for broader use, emphasizing rigorous testing to ensure accuracy. On another front, educational models have seen technology's profound integration. Yet, adoption disparities exist among educators, influenced by socio-cultural, economic, and personal factors. Investigating these determinants, the research method intends to use a mixed-method approach focusing on public and private schools in an attempt to discern the nuances of technology assimilation in education. Both projects highlight the necessity of aligning technological advancements with existing systems for enhanced outcomes.

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