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Caught in the Tractor Beam of Larger Influences: The Filtration of Innovation in Education Technology Design

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Abstract—While emerging technologies continue to emerge, research into their use in learning contexts often focuses on a subset of educational practices and ways of using technologies. In this study we begin to explore the extent to which educational designs are influenced by larger societal and education-related factors not usually explicitly considered when designing or identifying technology-supported education experiences for research study. We examine patterns within and between factors via a content analysis across ten years and 19 different journals of published peer-reviewed research on technology-supported writing. Our findings have implications for how researchers, designers, and educators approach technology-supported educational design within and beyond the field of writing and literacy.

Keywords—Writing, emerging technology, learning, curriculum, pedagogy.

I. INTRODUCTION

EDUCATION technology design, use, and research have traditionally been positioned as solutions to known, intractable problems of learning and motivation, a way to escape educational malaise, and a path toward higher efficiency, cost effectiveness, and better learning [1]. Identifying, modifying, and developing technologies to overcome educational challenges is a vital service to the field of education, yet the very context in which educational problems are named into existence largely constrains the points of departure for educational technology research and design [2].

In this study, we take an ecological approach, inquiring at the intersection of the interplay among cultural, educational, technological, and domain-specific discourses. We explore the potential for these discourses and other factors to influence and constrain the study of writing technologies within education.

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II. THEORETICAL FRAMEWORK

The process of designing and developing educational experiences has a long history and a host of defined instructional design theories [3]. Circulating among these theories are additional elements, theories, and positionalities that contribute to the ways a particular design is realized. Garrett [4] suggests there are four elements for consideration in the design and development of language and literacy acquisition experiences and applications namely: learning theory, educational context, pedagogy, and technology. These education-specific elements also exist with a co-influencing ecology that includes an array of additional metanarratives about education's place in society, technology's place within education, and notions of research epistemology [5]-[7].

The four elements above listed by Garrett certainly play a central role the design and development of technology-supported educational experiences within any domain. Reigeluth [8] details the centrality of aligning educational-design theories with curricular and learning theories. Yet we find it curious that curricular approach, epistemology, and educational metanarratives (among others) are absent from explicit consideration. Voithofer and Foley [9] as well as Der-Thanq, Hung, and Wang [10] point to the ways larger factors--often implicit in education and technology design--can influence the experience. Specifically, Voithofer and Foley state the importance of ensuring ongoing reflective epistemological resonance among education design orientations so as to create a more cohesive environment. Furthermore, [11] explains that education design should be understood as an interaction between the epistemological beliefs and personal proclivities of the educators, designers, and researchers, the educational contexts and participants/learners, as well as the larger contextual realities in which and for which the design is created.

We explore these notions by applying them to empirical research at the intersection of writing, technology, and education. While it is impossible to quantify or definitively know the impact of research on educational practice, its influence is multifaceted--representing one of the best ways to get a sense of which new and emerging technology-supported educational practices are under study [12]. We see this as a way to confirm and better understand the apparent homogeneity of technology-supported educational writing implementations and use cases that populate the literature.

Homogeneity occurs despite a burgeoning pool of emerging technologies and during a time of increasing technological ubiquity. We examine the elements and metanarratives mentioned above as well as other forces and more general elements in an attempt to better understand how they circulate, co-influence, and align in the research of technology-supported education designs meant to cultivate growth in writing.

III. Co-Influencing Elements

In the subsections below we unpack some of the societal and education-related elements we trace in our content analysis. We explain how we categorized different positionalities. If there is a generally acknowledged set of positions we used then we explicate them. If there is a dominant position within a particular element we unpack it along with the less frequently used elements. If the element was more open ended we describe the conceptual or societal terrain.

A. Curriculum

Ralph Tyler articulated an approach to curriculum that continues to dominate the field and influence educational experiences [13]. This approach begins with the identification of pre-determined goals which are then broken up into measurable, knowledge and skills objective. In fact Tyler's influence has been so robust that most education designers and researchers take the presence of measurable objectives as an unquestioned part of education. Societies in North America tend to gauge the efficacy of their educational system, school districts, schools, teachers, and students based on how well students demonstrate their understanding of measurable standards-based curricula via standardized testing.

In the late 1960s a group of educational design theorists re-conceptualized curriculum calling for a focus not on measurable objectives but rather on curriculum as an educational experience [14]. This re-conceptualized perspective encouraged learning experiences that used generativity, autobiography, and allegory to create an educational experience that folded the past into the present via the vehicle of subjectivity (both the teacher's and the students') [15], [16].

B. Learning Theory

Theories of learning abound [17]. Designing and developing educational experiences that draw on learning and instructional theories that are practically and epistemologically congruent with each other and with other elements of the design process is a complex, evolving endeavor [10]. In this research study, we organized learning theories into the four well-known and generally accepted categories: behaviorism, cognitivism, constructivism, and social-constructivism.

C. Pedagogy

Pedagogy is a point of exchange between curricula, theories of learning and teaching, and students within educational contexts [18], [19]. Direct instruction, project based learning, affinity-based learning among others are all seen as viable vehicles for realizing growth within a particular subject area.

D. Research Paradigm

Guba & Lincoln [20] outline five different paradigms that influence the development of research designs: positivism, postpositivism, constructivism, critical theory, and participatory. Similarly, [5] outlines four dominant research paradigms: positivist, interpretivist, critical theory, and deconstructivist/postmodern.

E. Technology Type

Technologies are at times coopted and sometimes specifically created for use in learning spaces. This burgeoning range of technologies capable of supporting learning and the development of writing can be categorized in terms of hardware/software dichotomies, by platform, by mobile/laptop binaries, and other methods.

F. Technological Paradigm

The SAMR model is a useful framework that is increasingly being used to guide how educational technologies are being utilized for instruction [21]. The name is an acronym that stands for Substitution, Augmentation, Modification, and Redefinition and it is intended to describe the ways in which educational technologies can have an impact on instructional activities.

G. Narratives of Technology Use

In addition to categorizing the type of technologies and paradigms used, it can also be both productive and illuminating to examine the narratives which researchers use to position technology. In other words, the narratives used to explain what researchers and educators were trying to achieve by using the technology can aid in the evaluation of congruence in terms of design and authenticity in technology use.

H. Narratives of What Writing Is or Could Be

Developing and ongoing conversations in writing studies and literacy studies concerning what writing 'is' or what it means to society, to schools, and individuals in the 21st century can influence the types of inquiry researchers pursue. The process of writing extends beyond exercises of textual composition to include communication through visuals, spatial arrangement, and a variety of ways that extend beyond paper, beyond text. Teachers and scholars are studying how technology is changing the way communication happens, how the multimodal affordances of technology create a wider range and heightened awareness about the multiplicity of literacies or, ways of knowing and expression [22]-[26].

IV. Methods

In this section we describe our initial research question, our data pool, and the analytical approach we used in this study.

A. Research Question

What are the positions taken by the authors on elements

such as epistemology and narratives about writing and technology?

B. Data Pool

Our inquiry entailed the consideration of ten years-worth of articles across 19 journals focused on writing, literacy, technology or some combination. These journals are listed in major research databases, and collectively offer some of the most up to date research and theorizing on the use of digital technologies within writing contexts. We read each article title and abstract, filtering specifically for texts reporting on research wherein individuals between the ages of 5 and 20 years old were learning or developing their writing and doing so via some form of digital technology. When necessary, we reviewed the methods and data sections to confirm that the piece described the writing context, instructional approach, intervention, and/or use case of the technology-supported writing practices under study. These filters created a pool of 106 articles meeting all of our criteria.

C. Analytical Approach

Analytically, we employed content analysis [27] that was primarily qualitative in nature [28], [29] to address our research questions. This approach is well known across the social sciences and supported our work of articulating our research scope, selecting and sampling material that fit the scope, identifying and refining aspects or frames, generating and grouping codes, and analyzing and inferring meaning based on different frequencies, manifestations, and absences of chording across aspects/frames/elements. Additionally, this approach has recently demonstrated its utility in investigating research on technology and education [30] and requires explicitness in terms of the data analyzed, their definitions, the population and context from which the data are drawn, the analytical boundaries, and the aim of the inferences [27], [30].

Some of the elements we looked at, such as research paradigm and learning theory, came with pre-determined categories while other elements (e.g. narratives of post-use, position of writing and society) were created as we identified and coded those elements.

Two members of our team coded each article used in the analysis. If the second coder arrived at different interpretations than the first she added a comment to the code she used explaining her rationale. Once the second coder had finished, the initial coder reviewed the interpretations of the second coder and revisited areas of coding divergence. In some categories, such as research paradigm, resolving the difference was necessary whereas in categories like metanarratives of what writing is, what was necessary was confirming that the two different codes captured two distinct positions held within the article. We coded a total of 53 articles with two coders.

V. DATA, THEMES, AND FINDINGS

As mentioned in the sections above, we took an iterative, exploratory, qualitative approach to content analysis with each member of the research team working collectively and individually to identify patterns and make connections within and between the overarching elements. The subsections below represent some of the findings we have identified/constructed based on our collective culling and coding of ten years of research on writing and technology in learning spaces. Collectively, these goals represented another set of co-influencing elements that were used to categorize the use cases in this study.

A. Learning Theories

While behaviorism was not identified as the type of learning theory used many interventions, its characteristics were present in several studies. For our analysis, behaviorist theories were identified in studies where: learners were more passively engaged in the learning process; behaviors were shaped through stimuli and reinforcement; content was highly sequenced and built on previous content; and/or when there was a strong testing-knowledge orientation. While projects that are designed based on the other learning theories might share one or more of these characteristics, behaviorist projects were considered those that elicited these more centrally.

Examples of how cognitivism was used in writing interventions and projects included those that considered the cognitive demands that are placed on students, tended to view students individually, as well as appropriately accessing auditory and visual channels [31], [32].

Constructivism is yet another learning theory that was found to be central to the articles in this study. We classified interventions and use cases as constructivist if there was an emphasis on students individually developing a deeper understanding of concepts by constructing their own meanings [33].

Finally, social constructivism was also featured prominently in the studies we analyzed. Similar to constructivism, there is an emphasis on students constructing meaning in relation to core course concepts. However, these constructing processes are considered to be more effective when engaged in social settings with peers [34]. Having students to use wiki pages to write a collaborative research paper together, thereby engaging in "communal constructivism" [35] would be one example.

B. Pedagogy

In this study, direction instruction was featured in approximately 14% of the articles that were reviewed. The most prominent pedagogical approach, however, were project-based strategies, which were found in almost a fourth of the articles. These pedagogies are those that engage students in meaningful projects or problems that they must complete during the course of the study. An example of these is digital storytelling projects where writing and literacy assignments were expanded to include such elements as videos and images [36], [37].

Also prominent in this study's articles were game-based, narrative, and scaffolded instructional strategies. Each of these comprised about 8% of the articles that were reviewed. Game-based approaches utilized pre-built games such as online simulated environments [38]. Narrative pedagogies include

those in which students engage with or create their own stories, sometimes in digital formats [39]. Finally, scaffolded instructional strategies follow Vygotsky-like approaches wherein students are supported in ways that gradually lead to self-sufficient competencies. An example would be using a mobile grammar app to help second-language learners improve in their self-editing abilities [40].

C. Research Paradigm

Using Lather's [5] categories, *positivism/postpositivism*, comprised approximately 36% of the use cases in this study. This category is understood as a research study that measures and quantifies student actions/artifacts. *Interpretivism* made up about 50% of our use cases. Research studies that focused on qualitative, 'in your shoes' type of research interpretation were categorized with this paradigm. Third, *critical theory* included less than 6% of our use cases. Use cases that were categorized according to this paradigm were those that focused on exposing, correcting, and confronting situations of inequality and power differentials. Finally, *postmodern* was used in less than 2% of cases. When it was used it included research studies that focused on deconstructing or highlighting disparities in language. As it relates to writing use cases, this paradigm is primarily concerned with how language and power circulate in a world of becoming. In addition to these four paradigms, we also included a *multi paradigmatic* category for those use cases that synthesized two or more of these four paradigms and approximately 4% of the studies did so.

D. Technology Type

We categorized technology tools by affordances. One group, Multimedia programs thus refers to approaches to communication in which meaning is provided not just through writing and text but through visuals, spatial layout, gestural, audio, and any combination of those meanings. Programs that are categorized as Multimedia and Multiliteracy allow for communication through a variety of modalities: i.e. using video which incorporates writing a script, creating visuals through filming, audio through sound and dialogue intonation, and gestural acts through an actor's performance. A second category to bundle technologies was Interactive Written Discourse (IWD) is a term coined by [41] as a designation of writing that is "a hybrid register that resembles speech and writing, yet is neither" (p. 10). Technologies with those characteristics could be email, instant messaging or chat, online discussion forums, and social media because of the way those medium allows for a fusion style approach to communication. Like Multiliteracy, IWD tools grouped technologies with shared features into thematic categories that reflect the common component.

E. Narratives of Technology Use

Understanding the goals for using the technology, and how those goals related to other categories, helped us evaluate congruence in design and authenticity in technology use. Categories were created to reflect what we expected to see, based on literature around the topic as well as what we did see

in the use cases. The goals we identified in our research included: assessment, to evaluate the learning outcome; creating a pedagogical shift, to move from transmission to constructivist ecology; efficacy, to achieve academic writing skills effectively; motivation and excitement, to help students to engage themselves in writing because of the love of the technology; organization, to increase efficiency of writing in terms of the ability to organize components of writing; scaffold active responses and reflection, to think more deeply about writing via given and received peer feedback; mirroring our technological world, to better prepare students for the our increasingly technological environment; empowering marginalized groups, to combine technology with grassroots social action; offering superior approaches, to provide better learning experiences than other technological or non-technological approaches; and evaluate expanded technological capabilities, to study new technological capabilities.

F. Narratives about What Writing Is / Could Be

Analyzing the metanarratives of what is writing in relationship with the top three technologies reveal distinct debates about the definition of writing as either traditionally situated in academic progress or as a rejection of those academic constraints in favor of emerging and changing beliefs about what writing is and could be. Writing is situated as both a tool for academic success and connected to performance. In that view, technology that helps to teach or tutor the student about writing, that is a program or app that assists with writing, or IWD's are preferred. When writing is defined as extending beyond the classroom either through wider cultural awareness, writing to self-reflect, or writing towards future professional development, more explorative multimedia technology is sought out in order to allow students more multimodal expression or a wider range of "writing" skill sets. When writing is viewed as a process in which the writer progresses through several revisionary stages, workshops, peer-reviews, and reflection, technology that is collaborative, like Wikis, or that assists the student in the process is sought out.

VI. DISCUSSION AND IMPLICATIONS

In this study we undertook a content analysis of research on writing technologies. Our findings offer a way forward toward valuable insights about the forces that co-influence each other and serve as a filter for the design, adaptation, and use of emerging technologies in learning settings. This line of research can have implications for how we think about technology-supported educational design and the education technology design process.

Learning theories, which may be both implicitly and explicitly held worldviews, appear to be correlated not only to the kinds of educational technologies that are chosen for a learning experience but also to how these technologies are utilized in support of writing. For instance, those use cases following a social constructivist theory were found to make use of social connection technologies (wikis, social media,

etc.).

Areas for future study include delving more deeply into how our categories might be refined and our findings leveraged to better understand the co-influencing dynamics elements exert on each other and ultimately on the range of technology-supported educational designs available to developing writers in and beyond school settings.

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