

Statement of Research

Executive Summary

I use perspectives in **sociotechnical systems** and **human-computer interaction** to understand what governs **trustworthy information processing and exchange** for stakeholders of novel information systems. Among these governing factors are institutional **trust** relationships (role-adherence, division of editorial labor) and individual **propensities** (cognitive biases, attitudes towards automation, risk preference, self-efficacy). I've applied this sociotechnical lens to key problems in **higher education** (learning analytics at scale, institutional support allocation, pandemic-era IT resource management), **social recommender systems** (editorial processes), and **financial risk profiling** (gamified assessments of information processing biases) domains. My research leverages a mix of quantitative methods (analysis of variance, multivariate regression, dimensionality reduction) and qualitative methods (surveys, user-studies, interviews, focus groups). My work has generated publications at top-tier conferences in CS education and human-computer interaction (**ITiCSE**, **UMAP**), and secured multiyear collaborations with the instructional design and learning analytics teams at Virginia Tech IT, and Be-IQ, a London-based behavioral analytics firm.

1 Overview

I work on issues of **trust** in the **user experience** of **information systems**, especially of social content recommender systems (SCRS) and learning management systems (LMS). I focus on how **editorial trust**, **transparency** and **fairness** are assessed and preserved on the web in the application domains of higher education and social media. I take a mixed-methods, interdisciplinary approach, and combine perspectives from organizational psychology (trust in teams, leadership), technology adoption studies (quality of system, use, and information) and big data analytics to examine:

(a) the degree to which domain stakeholders adopt novel, service-based information systems, such as a university-wide LMS, and the attitudes influencing it (Sections **2.2** and **2.3**, publications **C1**, **B1**)

(b) how *a priori* allocations of stakeholders' trust beliefs and editorial intentions are revised in interacting with information systems such as an SCRS, especially in the presence of automation and personalization, (Sections **2.1**, publications **C2**, **W1**, **W2**)

(c) how we can design to enable transparency, explainability, and collaboration in these editorial processes (Sections **2.1**, publications **C2**)

2 Prior and Ongoing Contributions in Doctoral Research

Editorial processes are a critical **guardrail** for a **trustworthy user experience** of novel information systems. An editorial process represents a consensus, formal or informal, of domain stakeholders' beliefs about **ability**, **authority**, **utility**, **safety**, and **responsibility**. My doctoral work investigates this expansive trust landscape from three perspectives: distribution of editorial labor in groups, evaluation of learning and support outcomes, and individual propensities.

2.1 Trust and the division of editorial labor in recommendation of learning resources [UMAP'21]

Recommendation algorithms frequently personalize their output using explicit and implicit signals of trust, for instance, the RS user's interactional awareness of their local neighborhood, or preferences of their

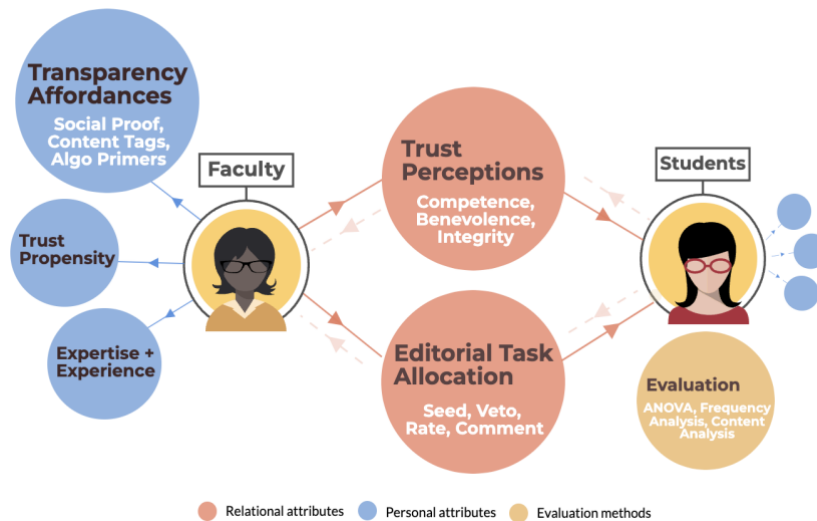


Fig 1. Editorial division-of-labor, individual propensities, and group perceptions of trust in higher education [C2].

trustworthy “friends” in a social network at large. While algorithmic awareness of a user's local neighborhood is important for producing accurate recommendations, real life recommendation tasks often involve user groups with differences in in-group roles, powers, and prerogatives. For instance, we are likely to have unique and meaningful trust relationships with family members, peers at educational institutions, work colleagues, and individuals with similar socio-political or religious in-group identity. These trust relationships, coupled with our risk attitudes and disposition towards automation, can inform the degree and pace at which we adopt, reject, or feel threatened by novel information systems.

In my work at UMAP 2021, we discover that faculty vary widely in their allocation of editorial tasks for educational recommendation. Some favor a **role-preserving** or conservative model, where students can view (and rate or comment on, in a subset of cases) suggested readings, but not create or remove them. Others lean towards a **collaborative authoring** or egalitarian model where students are actively involved in all or most authoring and feedback tasks. We also discover that this difference of editorial task allocations is linked to the trust faculty and teaching assistants place in students. The first group (role-preservers) typically consists of multisection, undergraduate, STEM courses, and stakeholder rationales often include beliefs in **instructor prerogatives**, **burdens of algorithm supervision**, and overall **student disengagement**. They also exercise high caution about socially-sourced transparency cues in the design of educational recommender systems. The second group (collaborative authors) is often single-section, graduate, non-STEM courses, and stakeholders often cite the **needs for student feedback** and **content moderation**. They also express marked optimism about **editorial transparency** for the entire recommendation process. The IT Learning Systems team at Virginia Tech is hoping to leverage these insights towards the design of a recommender system of learning materials aboard Canvas LMS (under development).

2.2 Platform analytics for learner intervention, and institutional support [ITiCSE'20]

Learning management systems (LMS) are increasingly the primary infrastructure for hosting and disseminating information between key stakeholders in higher education. A contemporary service-based (SaaS) LMS is a compendium of online communication, productivity, assessment, and class-management applications. LMSs support a diverse array of teaching and learning practices (remote teaching, self-directed learning, mobile learning, CSCW) and they have received widespread adoption and recognition across the global educational IT landscape.

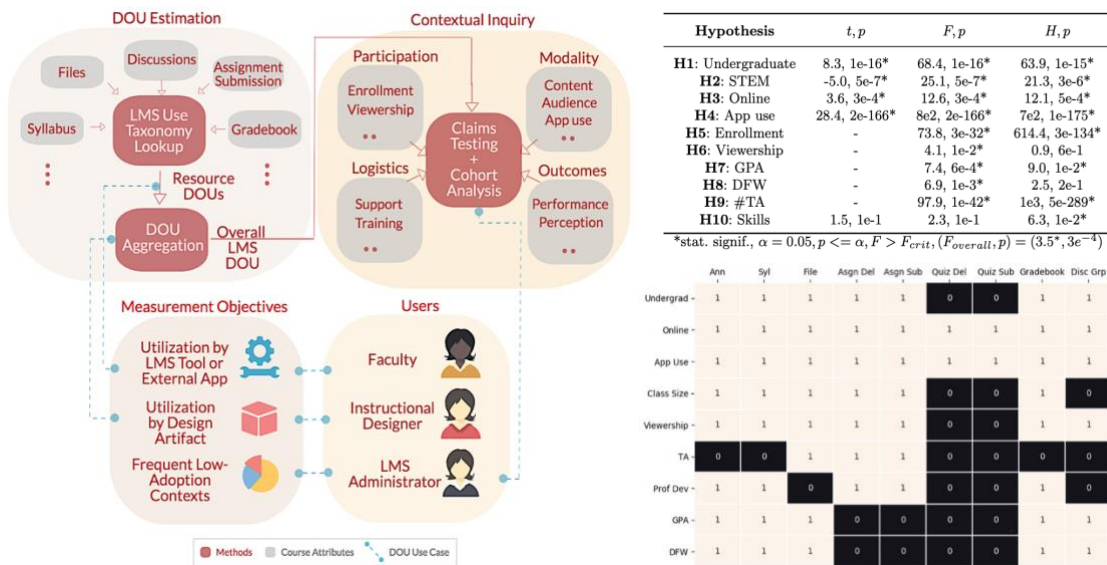


Fig 2. LMS platform analytics (Depth-of-Use, DOU) and its application to learner and institutional support [C1].

Understanding the adoption and impact of LMS tools is, therefore, central to faculty, university administrators, and instructional designers in better designing and evaluating course content. However, existing research on influencing factors of LMS adoption is largely limited to self-reported LMS use. It is challenging and expensive to (a) petition, store, combine, and analyze LMS data (course site contents, access logs, third-party app data) to identify meaningful use-contexts, and (b) evaluate learning, design and support outcomes across cohorts and departments. These, in turn, challenge IT leadership’s ability to **consolidate evidence on outcomes** and **best practices**. These also threaten faculty’s trust in new LMS tools, course redesign efforts, and professional development initiatives.

In my work at **ITiCSE 2020**, we address these challenges by developing “Depth-of-Use” (**DOU**), a first-principles process for assessing user engagement with LMS tools. At Virginia Tech IT, DOU has been successfully applied towards (a) adoption analyses of Canvas LMS services, (b) course redesigns, and (c) pandemic-era allocation of institutional support. We review these contributions as follows:

2.21 Adoption of learning management system (LMS) services

Our DOU-led adoption analyses of Canvas LMS at Virginia Tech reveal that issues of (a) **scale**, (b) **interoperability**, and (c) **ubiquitous access** are crucial to understanding the buy-in of LMS tools (fig. 2).

Issues of **scale** refer to LMS use patterns for high-enrollment, multisection courses. For instance, we observe higher use of Canvas LMS for **announcements** (mailing lists become increasingly inefficient in search and organization at scale), **assignment delivery** (multiple submission types, greater flexibility in scheduling take-home exams) and **third-party services** (for instance, Piazza’s popular forum management, content processing, and tagging features). Early adopters in the instructional staff of large courses gravitate towards the basic **housekeeping use-case** for LMS tools, such as communicating class times, office hours, course milestones, and grades. Faculty’s **ability to delegate** administrative and technology discovery tasks can critically help them balance their research and teaching duties and potentially migrate to new tools as class sizes increase. Issues of **interoperability** and **ubiquitous access** often determine the wider adoption of apps beyond their parent departments and research groups. Intuitive, safe, and swift **data sharing across course sites and educational apps** is essential to minimizing faculty’s cognitive burden-of-discovery and strengthening institution-wide LMS adoption rates. For instance, the enduring appeal of Canvas’s file and

quiz management apps Virginia Tech is in part because of their comfortable **integration with grading apps** (no manual data imports or data corruption). Consult publication **C2** for additional details.

2.22 Institutional support and instructional design

LMS administrators and instructional designers can use DOU to support departmental resource allocation, faculty development, course evaluation, and LMS evangelism. DOU can serve as a data-driven **signal of the need for personalized interventions** or **additional teaching support** for faculty micro-cohorts. For instance, low DOU courses often frequent the cohorts with low #TAs, and the hypotheses **H9** and **H10** in fig. 2 highlight that digital skill-building coursework alone does not appear effective in alleviating the cognitive burden of discovery required for rapid adoption. In an expert review session with five Virginia Tech instructional designers, three key **low-DOU cohorts** emerged:

(1) **Junk-drive** courses, prime candidates for continued technical support, use the LMS course site as a file drive. Often low-enrollment undergraduate STEM courses, nearly all do not have teaching assistants, and there is evidence of basic experimentation with native LMS services. (2) **Gradebook-only** courses, candidates for LMS campaigning efforts, do not use Canvas beyond reporting of final course grades. These are typically high-enrollment undergraduate STEM courses, with multiple TAs, heavy reliance on third-party apps, and an abundance of labs, recitations and group projects. (3) **Access-portal** courses, candidates for instructional design interventions, treat LMS as a gateway to third-party apps. The reliance on these apps is often a function of departmental precedents and faculty-perceived ease-of-use. Instructional designers should, therefore, make a particular note of faculty's technology self-efficacy and cognitive burden of transition to LMS tools.

2.23 Pandemic response

In the spring of 2020, an institution-wide **policy of emergency remote teaching** was rapidly enacted by Virginia Tech IT leadership in response to the COVID-19 pandemic. System administrators began with a **DOU analysis** conducted at the beginning of the term to determine **key low-DOU course clusters** (upper level STEM and general education coursework), frequent high DOU LMS features (typically the ones with lowest cognitive burden-of-discovery like files and gradebook), and frequent low DOU LMS features (quiz and assignment delivery). The administrators facilitated a rapid transition to remote teaching over a period of two weeks by focusing their support on low-DOU instructors. They designed training classes, in-person consultations, and in-depth documentation focusing on delivery and submission of assignments and quizzes via Canvas. The IT transition team was able to increase the total number of high DOU courses by over 49%. Two key takeaways emerge. First, instructors new to an LMS tend to first explore the tools they can utilize without significant cognitive effort. Second, the increase in courses with high DOUs for assignment delivery/submission, and quiz delivery/submission is often at the expense of low DOU courses in the same category. The instances of low -> high and medium -> high DOU growth suggest that in favoring online course assessments, Virginia Tech faculty responded to the transition team's focused development and support initiative. To conclude, **multistakeholder needs analyses** are essential to maximizing the **utility of learning analytic and institutional support services** in higher education, especially at scale. Differences of LMS use-case (housekeeping, access portal, etc.), editorial preference (conservative or egalitarian), technology self-efficacy, and individual propensity to trust can all affect faculty's uptake of new LMS services.

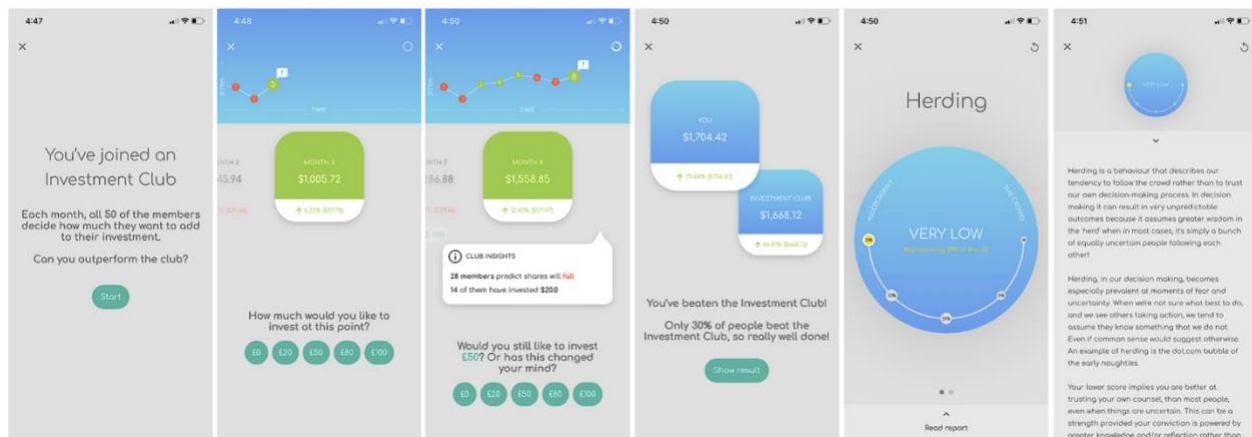


Fig 3. A demo UI (“Investment Club”) for self-assessment of “herd instinct”, the tendency to trust perceived expertise over independent assessment in investing decision-making. Created in collaboration with **Be-IQ, Ltd.**

2.3 Gamified psychometric assessments for self-evaluation of cognitive biases

In collaboration with Be-IQ, a London-based financial profiling company, I've helped develop a series of **gamified self-assessments of information processing** biases, including **herd instinct**, **framing**, **mental accounting**, **probability neglect**, and **present bias**. These biases are known to affect human decision-making in the investing, borrowing, and spending arenas. Figure 3 illustrates a demo UI for evaluating herd instinct: an investor's tendency to excessively trust the opinion of perceived experts over an independent evaluation of their risk appetite, a so-called “trust trap”. These assessments are part of a comprehensive mobile-friendly profiling service planned by Be-IQ for end-users. They rely on robust measurements of key cognitive biases, often tied to risk attitudes, individual propensity to trust, and trust in financial institutions. Among key research objectives going forward are (a) recommending self-directed educational materials to individuals susceptible to one or more of these biases, and (b) identifying how market conditions and global socioeconomic realities might reinforce or diminish these biases.

3 Career Goals

This section briefly reviews opportunities for future research and collaboration I'm planning to explore in advancing the design of trustworthy information systems in the educational and social arenas.

3.1 Future research directions

3.1.1 Trust and distrust in user experience of short-video recommender systems

Short-form video (SFV) recommendation is on the rise through platforms like TikTok, YouTube Shorts, and Instagram Reels. SFV is unusually successful in engaging its users for extended periods of time. Modern smartphone cameras and mobile video-editing solutions have lowered the barrier-to-entry of video production, and encouraged a new generation of SFV content creators. TikTok has reportedly posed competition for Google in the search market among young users (18-24). However, there is relatively little research on SFV users' media diets, in particular on issues of **trust in recommended content** (veracity, verifiability, safety) and **quality of the user experience** (attention management, minimizing isolation, discouraging social comparison). Threats of misinformation in domains of health, finance, and politics loom large in a platform like TikTok that is overwhelmingly used by young audiences. I plan to examine these **barriers to trust**, and identify their **antidotes** (transparency, explainability, collaboration) as perceived by data-owners and problem-owners: users, content creators, developers, forum moderators. I also plan to assist Be-IQ in advancing the financial self-directed learning space with short-form content.

3.12 Actionable cohort analytics for management of learning systems and institutional support

Sections 2.1 and 2.2 reveal that multi-stakeholder needs analyses are essential to effective allocation of **technical support**, **teaching assistance**, **professional development** services, **LMS evangelism** and **novel automations** in higher education. A failure to identify instructors' LMS use contexts, editorial preferences, dispositional trust of automation, and department-level precedents can limit the ROI of new learning media and IT infrastructure acquisitions. I plan on investigating these contextual factors, and providing cohort-specific strategy recommendations to my department for learner and institutional support.

3.2 Collaborations and funding opportunities

My research has relied on enduring, multiyear collaborations with partners in academia and industry. I plan to advance the research vectors identified in Section 3.1 and further these collaborations. I'll primarily seek research funding from NSF's Human-Centered Computing (HCC) program in the social impact and domain-specific HCI areas. In the pattern of my current collaborations with the Division of IT and Technology-Enhanced Learning and Online Strategies (TLOS) at Virginia Tech, I also plan on collaborating with offices of IT and instructional design at my university to implement DOU-driven cohort analyses, help identify the use-contexts of faculty's technology use, and provide cohort-specific strategy recommendations for learner and institutional support. Also in the pattern of the collaborative redesign effort of CS200 at Virginia Tech (Section 2.2, B1), I'd like to contribute to departmental conversations around curriculum policy updates, redesigns, and retooling of computing courses. On the behavioral assessment vector, I'll seek to continue my collaboration with Be-IQ towards their comprehensive risk profiling service. Among key research objectives going forward are (a) recommending self-directed learning resources to individuals about information processing biases, and (b) identifying how market conditions and global socioeconomic realities might reinforce or diminish these biases.

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