DESIGNING A CENTRALIZED FACULTY PERFORMANCE DASHBOARD: OPTIMIZING FEEDBACK AND SCHOLARLY DATA REPORTING

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Title: Designing a Centralized Faculty Performance Dashboard: Optimizing Feedback and Scholarly Data Reporting

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Abstract

BACKGROUND: Faculty members in higher education participate in a diversity of scholarly activities. Feedback performance and data on these academic contributions must be tracked for multiple formative and summative purposes including faculty development, promotions, and annual reporting requirements. However, this data are frequently not captured, primarily because most teaching institutions have not implemented a system to effectively collect and report this data.

PURPOSE: This thesis designed prototypes for an online performance analytics dashboard for Health Sciences faculty members, including researchers, teachers, administrators, leaders, and clinical educators. This project incorporated UCD (user-centered design) to focus on the end-users and seek to understand their needs and wants.

METHOD: McMaster University was used as a case study for this Design-Based Research study. Dashboard preferences were gathered from literature reviews, stakeholder interviews, document analysis, focus groups and interviews. These findings informed the build of a dashboard prototype. Multiple iterations of end-user evaluation and prototype revisions were conducted to refine the design. A constructivist grounded theory approach was utilized to analyze qualitative data from focus group and interviews to generate theory.

RESULTS: 25 key resources from the literature review were listed in an annotated bibliography. 10 stakeholders were interviewed. Several McMaster policies and forms were reviewed. 18 faculty members reviewed the dashboard and provided feedback. Qualitative data from focus groups and interviews revealed 4 main themes pertaining to dashboard needs.

CONCLUSION: By designing prototypes, this study revealed several requirements and considerations for the construction of a faculty performance dashboard. The dashboard must be customizable, dynamic, organized by user groups, and include specific requirements for the relevant faculty roles. The quality, governance and weighting of data in the dashboard must be considered. Notably, the implementation of this solution would enhance faculty learning and assessment, data reporting and faculty development in the Health Sciences.

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Glossary

MedSIS – Medical School Information System. MedSIS is a program that is used for administrative workflows within the University's medical education programs. This includes scheduling, evaluations, registration, and licensing.
MacFACTS – McMaster Faculty Academic Tracking System

MacExperts - An online portal containing research activities of McMaster faculty. Data collected in this system includes publications, educational background, area of expertise, and collaborators.

FHS – Faculty of Health Sciences

R4 - Mutually Agreed Responsibilities

AFP – Alternative Funding Plan - An agreement among academic physicians, teaching hospitals, and universities with Ontario Medical Association (OMA) and the Ministry of Health to provide non-repayable funding to faculty for teaching, research, clinical service, and educational contributions. This is a form of academic merit funding applicable to Ontario faculty members in the Health Sciences.

CBME – Competency Based Medical Education

EPA - Entrustable Professional Activity, a type of CBME assessment

CPD – Continuing Professional Development

P&T - Promotion and Tenure

KPI - Key Performance Indicators

1. Background

Scholarship of Faculty Members in FHS

Higher education institutions employ hundreds of faculty members who are essential to the success of the institution and education of students. Within the Faculty of Health Sciences (FHS), there is a diverse group of faculty researchers, teachers, clinical educators, and leaders who are shaping our future health professionals and leading advancements in the fields of healthcare and health research. This is accomplished through the various contributions that these invaluable faculty members perform, most commonly viewed within the context of research, education, administration, and service.[1–3] Each of these four general categories comprise a multitude of activities that faculty members conduct as part of their University appointment. The entirety of these activities makes up the individual portfolio for each faculty member, referred to as their scholarship.

Historically, the definition of a faculty member's scholarship and perceived range of academic functions was very narrow. Faculty scholarship was boiled down to include only basic instructional teaching (i.e. scholarly teaching in a lecture-based classroom), and research publications, a definition that excluded the many other forms of scholarly activities that are often pursued by faculty members.[2] This limited viewpoint, coupled with a lack of recognition by leadership, led to harmful and unproductive outcomes. Placing such a large emphasis on traditional research outputs contributed to the "publish or perish" mindset, whereby faculty members would feel pressured to produce a certain amount of research publications to stay relevant and maintain University rank.[4] Additionally, it was disheartening for faculty members to place time and effort into activities that were not recognized or valued by their employers.[5]

Over the past several decades, the definition of scholarship has continued to expand and evolve. The need for a broader and more inclusive view of faculty scholarship was first recognized in the 1990s by Ernest Boyer, who introduced a new and more sophisticated approach to how faculty scholarship is quantified. Faculty members contribute much more than the traditionally defined roles and, contrarily, partake in an extensive list of other roles and forms of scholarship. Boyer classified 4 domains of scholarship: Teaching, discovery, integration, and application. Teaching refers to the act of communicating knowledge to students in a way that facilitates learning and growth. Discovery is a synonymous term for traditional research where new knowledge is created. Integration refers to the process of synthesizing previously discovered information and forming new insights. Application may also be classified as service, which includes applying knowledge for the purposes of solving problems.[2]

To this day, the definition of faculty scholarship has continued to grow as the complexity and expectations of teaching increase.[6] This is especially true in health education. It is now recognized that trainees in this field do not learn the required skills and knowledge or become competent healthcare providers simply by observing and working alongside faculty supervisors for a duration of time. Clinical educators must provide teaching sessions, coaching, supervision, and assessments for learners. Various pedagogical innovations such as curriculum development, website curation, mentorship, and administrative tasks are other examples of activities that an FHS faculty member may contribute as part of their scholarship. Not surprisingly, the advancement of technology has contributed to the complexity of faculty scholarship as virtual teaching and collaborative pursuits through technology, such as podcasting or facilitating simulation sessions, have become more common.[7] Many of these alternate forms of teaching and service are now being recognized as potentially valuable to modern academia and, thus, to not

recognize or reward these new types of scholarship would be a disservice to faculty, students, and the higher education system. Additionally, there is a large amount of heterogeneity in scholarship across different specialties, departments, divisions, and even between schools.[2] Faculty members have different roles and areas of focus, and, therefore, not all forms of scholarship will be valued, prioritized, or completed in the same way across different groups. A researcher in a biochemistry lab will undoubtedly have a very different set of scholarship objectives compared to an instructor in a Health Education program. Each faculty member could have a distinct portfolio that is unique to their own University appointment.

FHS faculty members have particularly unique roles and responsibilities. These faculty members typically fall into one or more of the following roles: 1) Clinical Educators, 2) Researchers, 3) Academic teachers and 4) Leaders and administrators. Clinical educators include healthcare providers employed by Universities who both provide patient care as well as education for medical trainees.[5] The clinical service responsibilities adds another layer to the scholarship of clinical educators who provide both hands-on and theoretical teaching for clinical trainees.[8] This can be done across a range of learner levels (e.g. medical students, clinical clerks, residents, fellows), programs, and specialties and can include duties such as inpatient rotation supervision, facilitating simulation sessions, or coaching a student through a medical procedure. However, the field of health education has changed considerably over the last several years, partially due to the introduction of Competency by Design (CBD), the new framework for medical education implemented in Canada.[9,10] CBD places new expectations on faculty members to take on even more roles and responsibilities for medical education programs. In addition to these new demands, physicians are required to participate in programs through their professional association which mandates the completion of a certain number of continuing professional

development (CPD) activities.[11] Therefore, the contributions and activities of FHS faculty members are very different from an Engineering Faculty Member, for example.

As Middaugh 2001 stated, "Faculty members do not just teach, just do research or dedicate themselves solely to public service. Higher education is a complex enterprise and any discussion of accountability and productivity must take account of that complexity."[12] In fact, it is clear that FHS faculty members hold multidimensional roles which include a myriad of activities, all of which produce data on the faculty member, which will be discussed in the following section.

Faculty Data

The previous section summarized the complexity and variety of scholarship for faculty members in Health Sciences. Faculty data are the facts and information that are generated from the academic activities that a faculty member contributes. The definition of faculty data in this context is very inclusive and broad. However, data that is unrelated to the faculty member's academic performance or service would not be qualified as 'faculty data'. Assessments on faculty member performance is an example of faculty data, most commonly composed of student evaluations.[13–15] Data on the details of service and scholarly contributions are another type of faculty data. Examples may include the weeks of clinical supervision provided, courses taught, publication count, or number of committees a faculty member is involved with. This is just a small subset of examples; other faculty data exists in various internal and external systems. Capturing, analyzing, and managing faculty data is used by many stakeholders and is important on a micro (individual faculty member), meso (department), and macro (institution) scale.

Further details about the use of faculty data for different purposes are described in the following sections.

Formative Purposes

For individual faculty members (micro-level), data on their performance and productivity are an important source of formative assessment, which are essential for promoting learning and growth. Formative assessments are more informal and opportunistic, whereby feedback is provided to help identify a faculty members' strengths and weaknesses and stimulate improvements in performance.[16–18] Students receive feedback from their teachers with the expectation that it will enhance their learning; the same is true for faculty members. Data and assessments provide valuable feedback on faculty performance quality, scholarly output, and effectiveness of teaching. Because healthcare, medical research, and clinical education are continuously advancing and becoming more complicated, it makes sense that a faculty member who practices in these areas should continue to learn and improve throughout their career. The environments of health education are shifting toward a culture that values continuous improvement, and it is known that it is extremely valuable to provide faculty members with feedback for their own personal development and career growth.[17,19] In both the Health Sciences and many other disciplines, the provision of feedback to faculty members has been shown to result in many positive outcomes. Studies have demonstrated that feedback can promote learning and skill development[20], improve teaching performance, identify areas of weakness,[13] and result in positive changes to faculty behaviour.[13,14,21] Feedback can also increase faculty knowledge and skills,[19] overall satisfaction,[19] self confidence, and motivation.[22]

In addition to the aforementioned benefits, investing in formative faculty feedback also positively impacts health education. Behind every health professional are all the supervisors and mentors who helped them develop competencies during training. Quality teaching from faculty members is positively correlated with the quality of education that medical trainees receive.[23,24] In this way, there is a downstream impact of teaching effectiveness to the quality of healthcare. These medical trainees represent our future healthcare providers. Therefore, it is important to promote the development of effective faculty members who can provide quality education and train competent health professionals. From an institutional level, evidence of an effective faculty development program and employment of high-quality teachers are essential, as these faculty members are more resourceful and productive. This makes it more cost-effective and efficient to employ faculty members who are high performing, produce high levels of academic output, and provide excellent learning opportunities for students.[25]

It is important to note that the way in which feedback is delivered can make a difference to the outcomes, and there are a number of variables that will impact how a faculty member perceives, processes, and responds to this feedback. Feedback can make faculty feel imposter syndrome, [26] ignore the feedback,[13] or experience negative emotions.[14] Some of the variables that affect how faculty members make use of feedback include the stage of career, institutional support, or availability of a coach. Other variables such as the representation or mode of delivery can be more readily controlled so that feedback is more likely to lead to constructive reactions by the faculty member. For this reason, it matters <u>how</u> faculty feedback is presented. The provision of feedback and resultant reactions and outcomes represent a complicated phenomena. In order to support a feedback system that produces positive outcomes for faculty members, it is

important to ensure that data are delivered to faculty in a way that is accessible, constructive and intuitive.[27]

Summative Purposes

Faculty data are also used by various stakeholders as summative assessments, where faculty are evaluated using more formal and standardized assessment methods which are used to hold faculty members accountable for their performance. These summative assessments serve more high-stakes purposes compared to formative assessments, meaning they hold a high value and can impact faculty promotions, retention, and payment.[13,16–18] Thus, the summative uses of faculty data to elicit outcomes represent data-driven decision-making processes.[21] At the macro level, valuable insight on the trends and performance of faculty can be used by department chairs or divisional managers. Performance analytics on faculty can help determine organizational effectiveness and be used as a type of 'quality assurance' by the institution.[28] Additionally, data on faculty scholarly activities must also be reported to governing bodies, such as the Ministry of Health and the Ministry of Colleges and Universities (MCU). Universities are expected to fulfill a certain level of teaching and academic output. Therefore, reporting this data is required to keep the institution accountable and to determine if they are meeting the benchmark for productivity. This is important for funding purposes, accreditation requirements, and to ensure the University and respective Departments are aligning with the organization's overarching mission and priorities.[25,29,30] Demonstrating high levels of productivity and quality teaching also helps attract students and increase the rank of the University in a competitive way.[31]

Further, faculty members are typically expected to meet with their department or division chair on an annual basis for a career review. During these meetings, the chair will review what the faculty member has accomplished over the past year, the evaluations they have received, and the details of their appointment in order to assess performance, provide career advice, and plan for the upcoming year.[32] The R4 is the abbreviated term for the 'Mutually Agreed Responsibilities' of a FHS member. This is a document that allocates their expected contributions within the domains of either research, teaching, administration, or clinical work. During annual review meetings, the faculty member's R4 is reviewed and revised for the upcoming year. If data on faculty performance and scholarly outputs were easily accessible and comprehensive, it would help provide context for these annual reviews, which could result in more evidence-based and helpful discussions and coaching. Unfortunately, faculty data reports are often incomplete and dispersed across multiple systems which are not easily accessible or conductive for the Chairs who run these annual reviews.

There is also a financial incentive for Faculty members to report their scholarly activities. Faculty who are productive will acquire additional merit that is rewarded through bonus payments or salary increases.[32] For Health Sciences academic physicians and faculty members who work in Ontario, this additional fee-for-service funding is provided through Alternative Funding Plans (AFP). This is a contract among the University, the Government and the Ontario Medical Association (OMA) that provides monetary bonuses for faculty members to provide research, clinical service, and education. However, merit can only be rewarded when the faculty contributions are captured and documented, hence the value of scholarly data.

Importantly, faculty data are also required for reasons pertaining to the faculty member's appointment with the University. When they are hired, faculty are designated a teaching and/or

research stream or track that they will follow in their appointment. In their respective stream, faculty members will undergo reappointments throughout their career, and may also gain tenure or teaching permanence. By demonstrating a certain quantity and quality of teaching and scholarly contributions, faculty members can progress in their respective appointment stream or tenure-track. This may include moving up in rank (assistant professor, associate professor, professor) or being promoted to a permanent position (tenure). When it comes to promotion, all of the faculty member's data on their contributions and assessments are compiled into a portfolio or dossier. This aggregated portfolio is then used by Department Chairs and Promotion and Tenure (P&T) reviewers to evaluate whether that faculty member should be promoted. Thus, the promotion process relies on a comprehensive report of faculty performance and productivity. Different activities have different weighting and value, but the promotion decision is based on an evaluation of the quantity and quality of teaching and scholarly contributions. Faculty data are therefore valuable because it provides evidence of these P&T requirements, and a large percentage of faculty members are motivated to be promoted.[1]

The ways in which promotion and tenure decisions are made have not been without their challenges. Firstly, many faculty members are missing data on their contributions and, consequently, do not qualify for promotion. Even with the digitalization of a lot of this data, it is not always documented or captured, leaving no proof or record of the faculty member's activities. Secondly, the data and performance metrics that are most valued by Department Chairs and P&T Committees will vary to some degree.[33] Many have also expressed concerns over the lack of recognition for non-traditional activities (as described in section 2.1) by P&T committees.[5] Concerns have been raised about how equitable and data-driven these P&T decisions are, and whether it is driven by objective data or impressions or judgments.[34] Hence, it

is important that a complete collection of faculty data be used in the data-driven decisions associated with P&T and allocation of merit pay. These various summative uses for faculty data help to incentivize faculty members to put forth effort to teach, research, and provide service. In this way, faculty members may have an extrinsic motivation to perform these activities as well as document them.

Benchmarking and Assessing Success

Now that the different types and uses for faculty data have been outlined, the question still remains of how success can be quantified. How can data show which faculty members are exemplary? This is not a straightforward concept.[29] Part of the challenge is deciding which key performance indicators (KPIs) accurately represent faculty performance and productivity. Many KPIs for faculty performance are cited in the literature and are currently utilized in higher education. KPIs to measure scholarly productivity include publication counts, citation counts, grants received, and the h-index.[3,35] Student evaluation scores, number of courses taught, teaching awards, or peer observations of teaching are examples of metrics used to assess teaching performance.[3,34]

There are several considerations when using data to determine faculty performance and productivity. While they can be useful in the right context, most metrics alone are often not adequate measures of performance. Despite the frequency, many metrics are used because they are convenient, cheap, or easy and not because they are the most accurate.[2] Student evaluations are a prime example of a commonly used assessment tool which has evoked concerns about its reliability and accuracy. Student assessments may be biased[36] and show low correlation with performance.[37] It is also possible that student ratings may be influenced by other confounding

variables such as instructor popularity,[38,39] subjective impressions of faculty,[40] or grade expectations.[3,18,37] Additionally, not every task or activity undertaken by faculty will take the same level of time and effort, making it difficult to measure productivity with regard to efforts.[3] Activities and measures are likely to be weighted or valued differently depending on where a faculty member is appointed. Comparing the publication count of a biomedical researcher against that of a primary physician would not be fair, given their different areas of primary focus (research vs. clinical service), unequal level of publication opportunities, and the contrasting scholarly productivity norms that exist across different specialties.[40] Priorities will vary across schools, roles, disciplines, and departments.[2,34,41] Essentially it is difficult for everyone to agree on what determines "quality". To allow for more equitable and transparent evaluations of performance, decisions need to be made explicit as to which activities and performance indicators are prioritized for each particular group of faculty.[33,34]

Finally, relying on a single KPI or assessment does not measure the overall productivity or performance of a faculty member. Many other forms of academic work or innovations are not included in any of the available indices, such as clinical innovation work, leadership initiatives, creative pursuits (e.g. newspaper articles written), public engagement (e.g. social media participation), or non-traditional teaching endeavors (e.g. module development, podcast delivery). By only using the traditional measures, the many other beneficial forms of scholarship are not recognized or rewarded. Moreover, there is also a risk that focusing solely on such few metrics will incentivize faculty members to perform the tasks that are more likely to be rewarded. If designing a course curriculum is not prioritized when measuring performance, a faculty member may be more inclined to invest more time into publishing manuscripts because that is what is deemed as valuable. Thus, it is important to take these other faculty contributions

into consideration, otherwise there is a risk for faculty to stray away from the other activities that bring a lot of value to higher education and healthcare.

Despite the challenges in measuring faculty performance, it must be considered because these measurements are used to make executive decisions about promotion, reappointment, hiring, merit payments, and awards. Faculty data must be leveraged to measure performance and productivity in a more objective way, rather than relying on subjective assumptions or impressions about a faculty member.[34] According to the literature, it would be best to incorporate flexibility in this process. Multiple measures of performance should be used to provide the most accurate assessment of a faculty member's productivity and quality of scholarship. A holistic approach to measuring assessments is needed, including qualitative and quantitative data acquired from multiple sources.[3,5,34,40,41] This data can provide valuable insights on the quantity and variety of teaching and scholarly activities of faculty members, as well as the quality.

Gaps and Proposed Solution

While vitally important for both the individual faculty members and the institution as a whole, many gaps exist in the collection, management, and reporting of faculty data. While a faculty member may participate in several activities, these contributions are often not recognized because the University does not possess a centralized system that effectively captures the data nor produces a comprehensive report on the activity or performance feedback.[32] Modern technology has led to more robust databases and systems that are capable of storing and analyzing large amounts of data, as seen in data warehouses (e.g. Oracle) that can perform functions such as data mining, business intelligence and other predictive data analytic techniques.

However, these systems have not been leveraged for faculty data in many Universities. At present, faculty data are hosted in a variety of disparate systems. Examples of internal systems at McMaster University include learner scheduling and assessment systems (e.g. MedSIS), administrative information systems (e.g. Mosaic), research profile systems (e.g. MacExperts), and faculty academic contributions tracking systems (e.g. MacFACTs). Systems external to the institution include examples such as research analytic programs (e.g. Publon, Google Scholar) or hospital Electronic Medical Record systems (EMRs). A lack of interconnectivity between these systems means that the data exists in silos. Compiling the data from these multiple systems is often a manual and onerous process for faculty members or delegates. Data trends and relationships cannot be leveraged because the data is not aggregated and analyzed. This is a missed opportunity for data discovery and knowledge extraction.[42]

The data entry piece is also not currently adequate at most higher education institutions. There is little automation in how data is captured or shared between systems. To collect and track the details of scholarly activities and evaluations, either the faculty member or an administrator must spend time and effort to manually enter the data themselves. While some manual data entry is inevitable, more automation and interoperability between systems could prevent the duplicate data entry that is currently required. For example, data on clinical supervision activities are entered into MedSIS for student evaluation management. This data must be entered again into MacFACTs for faculty contribution reporting. If there was communication between these two systems, the data would only need to be entered once. As a result of such inefficiencies, a lot of data on faculty members are not documented into MacFACTS and this has a negative impact on their merit and promotion prospects. The data is useless if it is not readily available for those who need it. These gaps in faculty data management

have been a longstanding issue at McMaster and other local and international teaching institutions. The lack of interconnectivity between different systems continues to be a major hindrance. Further, faculty members do not have the time or expertise to properly analyze their own data through statistics (e.g. finding correlations in data), interpretations, purposeful reflections or extraction of actionable follow-up goals.[43] This is a common problem because the majority of faculty members are not experienced or knowledgeable in pedagogy or educational data analysis. These faculty may struggle to make sense of raw data that has not been analyzed, which does not inherently provide actionable or intuitive information without data analysis.[43]

Because of these obstacles, scholarly data is not often used to its potential in higher education. To take advantage of faculty data, we need effective *data visualization*. This concept refers to the representation and visualization of data in forms such as charts or graphical elements that can help facilitate more effective and efficient processing of the data.[44] Rather than through tables or lists, data visualization allows users to better understand their data through trends, patterns and analyses.[42] Thus, higher education needs a system that can compile, analyze, and provide visualizations of data for faculty members. This could be accomplished with an enterprise system, defined as a large system that can manage, track and automate the various operations of a business, as well as facilitate the storage and sharing of large amounts of data.[45] However, there are very few existing commercial enterprise systems that have this functionality for faculty data. An informal web search revealed some existing solutions; however, this is still a very untapped market. A competitive analysis (Appendix A) shows that amongst the small number of solutions, many are expensive and do not meet all the needs of FHS faculty members. It is clear that FHS faculty members are unique in their data and reporting needs. Thus, any enterprise solution should account for the broad and diverse range of academic functions that

FHS faculty contribute. To further complicate things, each University uses their own suite of systems and databases, which are often not easy to integrate. This makes it difficult to create a one-size-fits-all enterprise system that is capable of 'talking' to all of these systems.

Essentially, there are two parts to this problem. The first pertains to a need for a back-end system to collect and compile the different sources of faculty data. The second is that there needs to be a front-end data visualization interface that can provide a report of faculty data so that they can quickly and easily view and understand their data. Dashboards are one of the most popular and effective forms of data visualization.[42] A dashboard can be defined as: "A visualizing tool which provides awareness, trending, and both planning and actual comparisons, frequently visualized in a slick simplified user interface."[46] A dashboard would effectively present compile data from multiple sources to provide a summary of important information that faculty members could access at a glance.[47,48] Typically, dashboard visualizations are compiled onto a single screen where high-level information can be displayed, with the option of navigating to more in-depth information on particular components. The development of a faculty performance dashboard would be advantageous for rapidly disseminating information to the faculty member on how they are performing in a manner that requires minimal effort and helps them understand the data.[47] Tables and long reports of data are more difficult and time-consuming for faculty members to view and interpret.[49] Alternatively, if designed properly, a dashboard could help faculty members see their strengths, areas of improvement, trends, and steps required to progress.[47]

Higher education actually falls behind several other sectors that are already using web-based dashboards. Dashboards are used in the healthcare field to communicate relevant clinical information to healthcare providers in the ICU,[49] Emergency Department,[50,51] Radiology

Departments[52] and other areas. The value of dashboards within education has also been demonstrated in the business sector, especially in marketing, sales, operations, and finance.[42] Less work has been done to develop dashboards at the intersection of healthcare and education. One example is the study by Thoma et al to design performance dashboards of Emergency residents for the purposes of Competency Based Medical Education (CBME) decision-making.[5 3] One example by Lewis et al[32] developed a faculty data management system to serve the needs of radiology faculty members; however, it focused more on manual data entry, rather than data integration from existing systems where the data may already exist. Further, this paper did not provide a robust/powerful reporting tool that is needed. Otherwise, to the best of my knowledge, little work has been done to develop performance dashboards for the faculty members who work in the Health Sciences. Thus, little is known about what this type of dashboard should look like or what the requirements would be.

UCD and User Experience

When developing tools such as a dashboard, it is not enough to simply create a program that is functional and free of errors. This refers to the 'usability', which will be important once the construction phase of the dashboard and back-end system takes place.[54] Ensuring good usability helps prevent confusion and frustration in the end-users, but it is imperative that the product also provide a good user experience (UX). UX is a concept that extends beyond usability, aesthetics, and functionality of a system.[55] UX looks more broadly at the user's perception and overall experience with the product or service.[54] It aims to satisfy the user's needs and provide quality experiences with the tool through more efficient, enjoyable, engaging and meaningful interactions with the tool.[56,57] Good product designs will provide a good user

experience. Unfortunately, it is easy to create poor designs and user experiences, particularly when designing dashboards. Developers often try to fit too much information onto a single screen, which then ends up looking cluttered and confusing. Data may not be displayed effectively, the wrong charts may be selected, or colour and other distracting decorations may be overused.[47,48]

Creating a good dashboard design means avoiding many of these common design mistakes, but also using design-based thinking to best understand the needs of users. This is accomplished through the process of *requirements gathering* to learn about the needs, motivations, emotions and attitudes of the end-users. We must consider their internal thought processes and how they will interact with our product. This helps the designer to identify the features and characteristics the product should have so that the end-user will use the product.[54] Collecting and analyzing these needs is what makes up a user-centered design approach (UCD), a philosophy that ensures the design is optimal for the end-user. Good designers will empathize with their clients.[54,58,59] In this way, all design decisions should be made through the lens of the end-user and not the own designer's viewpoint.[55] Good designers are also able to see through what users say they want, because the perceived needs that clients articulate do not always translate to what their unrealized needs are. In other words, people do not always know what they need. For this reason, gathering requirements is more than simply asking someone what they want. It is a longitudinal process of interpreting what they say and unveiling their unperceived needs.[55,56,60]

However, many companies skip this step or forget about User Experience. This is problematic because without a good user experience, the tool will show poor adoption rates. Users who have a negative experience will not continue to use a program.[56] If time and money

were invested into developing a dashboard that did not offer a good user experience, faculty members would never look at it. The University would have lost money, valuable time, and efforts would be wasted, and faculty would likely end up even more frustrated and confused than before.[61] Thus, investing time into using a UCD approach to collect and analyze requirements is essential when creating a tool such as a dashboard. It must be designed for a broad range of users and consider their needs and wants in all phases of the design process.[60]

2. Project Objectives and Scope

The gaps in faculty data management reporting have been outlined in the previous sections. This project aims to formulate a solution to address these gaps by designing prototypes of a web-based faculty performance dashboard for Health Sciences faculty members. The purpose of these dashboards will be to provide a comprehensive report of faculty data, compiled from various sources, that will provide both formative and summative benefits. The dashboard will help faculty members improve their performance and productivity, as well as support the processes of annual reviews, P&T and academic merit reporting (e.g., AFP). The end-users of this dashboard will include faculty members in the Health Sciences department, spanning across all positions including researchers, teachers, clinical educators, and leaders. Due to the unique needs of the end-users, coupled with the lack of off-the-shelf solutions that exist, the decision to design a custom product was justified.

This tool being developed will only be beneficial if the target end-users want to use it. Therefore, this project prioritizes creating an optimal design for the prototype that will result in a good user experience.[47] We will seek to do this by taking a UCD approach and focusing the

project on requirements gathering and collection of feedback from our target end-users. The goal will be to better understand the perceived and unperceived needs of our end-users so that we can answer the following questions:

- What are the potential types and sources of faculty data?
- What data should be included on the dashboard?
- How should we display this data (what kinds of visualizations, organization of pages)?
- How are the needs different across different types of faculty members and roles?

For the purposes of this project, we investigated what faculty would want on a dashboard in an 'ideal world'. In this way, we defined faculty data as 'any information on a faculty member, pertaining to their appointment or work in their role, that would be of interest to the faculty member or other stakeholders'. This is a very broad and general definition, which was used on purpose. This project sought to learn about what faculty want out of a dashboard, both in a current and future state. Therefore, no restrictions were placed on the types of data that would be considered. Additionally, the prototypes will be designed specifically for the use of FHS faculty members at McMaster University. However, insights and design requirements will be obtained that could be generalizable to other departments and institutions.

When devising this dashboard, it is important to clearly define the objectives for the product as well as what the user wants out of the product.[56] This study focused on how to best align these objectives and user needs, while also gaining other theoretical insights in these areas. The objectives of the dashboard are as follows:

- Compile summaries of data and feedback on faculty performance into a one-stop-shop tool.

- Effectively present and quickly communicate data through visualizations.[56]
- Present the data in a way that will serve the aforementioned formative and summative purposes described (faculty development, annual reporting, promotion and tenure and merit).
- Be intuitive for all types of FHS faculty members. The dashboard should be applicable across all FHS roles, specialties, and characteristics such as computer literacy.

The project takes a robust, scholarly approach to the dashboard design by taking pertinent findings from the literature and data collected from this study, and translating them into requirements.[58] The process of designing these dashboard prototypes will demonstrate the end-user needs for a front-facing reporting tool, which will then both inform and justify the construction of a back-end system that is capable of data management. While the construction phase of building an actual dashboard is outside the scope of this thesis, learning about the design requirements will serve as a foundation for future developments in this project. In this way, this project will build low-fidelity prototypes to reverse-engineer the dashboard tool.

3. Method

Design thinking was used to best understand the end-users and translate their needs into requirements for the dashboard.[54] Several steps were required before arriving at the final dashboard design. First, I sought to understand the current state of the problem both at McMaster University and other institutions. I then gathered ideas for the dashboard and collated these ideas into a list of initial dashboard requirements. These initial requirements were prioritized (by weighing them against the dashboard objectives) and then used to populate the dashboard prototypes.[58] Finally, the prototypes were shown to faculty members to assess and provide suggestions through multiple iterations of evaluation and refinement.

Design-Based Research

This project used a design-based research (DBR) methodology. McKenney & Reeves 2012 define educational design-based research (EDR) as, "A genre of research in which the iterative development of solutions to practical and complex educational problems also provides the context for empirical investigation, which yields theoretical understanding that can inform the work of others." [62]

While the catalyst of my work was to solve a complex problem within a real-world educational setting, my project also aimed to use theory to inform the prototype design. In turn, it was also the intention that the findings from this project will provide valuable insights to other communities regarding faculty data management and dashboard design. Therefore, my project sought to use theory to design a real-world solution at McMaster University, while also

contributing theoretical insights and practical findings, particularly where eHealth and health education intersects. Thus, the bridging of research and real-life practice deemed DBR as a suitable methodology for my thesis.[62]

Additionally, another hallmark feature of DBR is the focus on complex problems that are situated within complex environments. The management and reporting of faculty data in higher education is an extremely complex problem due to the breadth of data types, data sources, various uses for data, and the complexity of faculty scholarship. Further, the environment in focus is indeed very complex. Universities and the FHS are a dynamic, complicated group with many divisions, specialties, and faculty members, all with their own behaviours and attitudes.[29] DBR research embraces the complexity of these types of problems. DBR also employs an iterative approach, which is an important strategy for design-thinking and UX work.[55,62,63]

Following the framework outlined by McKenney and Reeves,[62] my thesis followed the first 3 phases of a DBR project, with the concurrent goal of gathering user requirements and designing a faculty performance dashboard prototype (Figure 1). The fourth phase (implementation) was deemed out of scope for my thesis as it would require much more time and preparation to successfully construct and implement the tool into practice. Instead, the focus of this study was designing prototypes, which is an important step in DBR. Low-fidelity prototypes are easier to change in response to feedback, thus allowing for quick cycles of prototype design and revision, referred to as a 'meso-cycle".[62,64] Figure 1 shows a meso-cycle, comprising phase 2 and 3.

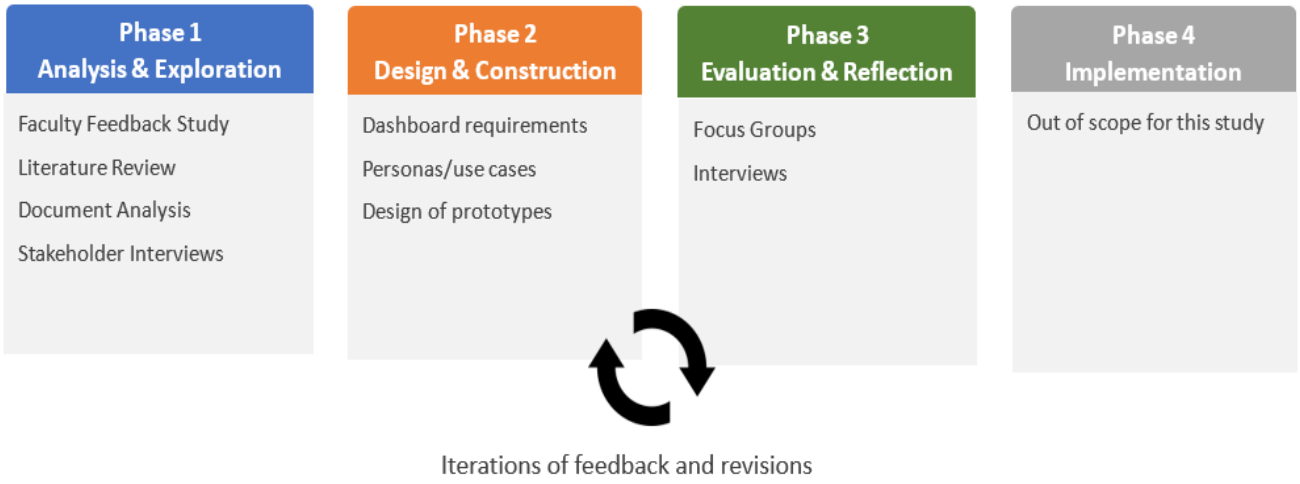


Figure 1: Study phases within the DBR framework

Phase 1) Analysis and Exploration

The initial project work involved a thorough investigation of the problem and current state, conducted using the methods outlined below.

Faculty Feedback Study

We recently conducted a qualitative study where we asked faculty what performance feedback they currently receive and what feedback they want. We conducted semi-structured interviews with McMaster FHS faculty members and used a grounded theory approach to perform a thematic analysis of blinded interview transcripts. The findings from this unpublished manuscript provided helpful insight for the dashboard design, as well as the current gaps in faculty feedback.

Literature Review

An informal review of the literature was conducted on the web to learn about the principles and theories that could help inform my project. Journal articles, books, blog posts, commentaries and podcasts were consulted in this review. I reviewed the literature on the various uses for faculty data in higher education, including faculty development, promotion and tenure and merit payments. To learn tips and best practices for UX design and data visualization, I consulted a variety of resources including books, articles and blog posts written by experts in this field.

Document Analysis

A document analysis was conducted to gather supplemental information that could provide background context around the research topic. In order to better understand the processes that impact FHS faculty members regarding their appointments, promotion and annual review processes, McMaster University policy documents were reviewed. The aim was to learn how the tool being designed could help support these processes. A list of the MacFACTS roles (as included in the MacFACTS system) was reviewed to better understand the different possibilities of scholarly activities and how they are reported or categorized. MacFACTS is the current in-house database used to enter and store data on faculty activities at McMaster University.

Additionally, sample AFP forms were reviewed to clarify how faculty are expected to report their data for merit funding purposes. This helped determine how activities are named, weighted and categorized when faculty members complete their annual merit forms. An example of an R4 document was also analyzed to see how contributions may be broken down by roles, depending on the individual faculty member.

Stakeholder Interviews

This study explored the current landscape of faculty data management at McMaster University to learn about why the data is collected and how it is used. This was done by interviewing stakeholders at the University to gain an understanding of the current state and gather ideas, knowledge and opinions on the project from multiple points of view. Stakeholder interviews are recommended as one of the first steps when scoping out the needs and requirements for a system.[58]

Stakeholder interviews were conducted with multiple individuals at McMaster University. Relevant stakeholders included those who had either already expressed an interest in the project or were identified to be impacted by the implementation of a faculty dashboard. This included individuals who would be involved in at least one step of the business operations associated with the dashboard. For example, department administrators would be involved in the promotion and tenure preparation process. A financial manager may use the dashboard to calculate merit-based compensation. Considering the size of FHS, the proposed tool would impact many stakeholders at McMaster. Appendix B outlines the various stakeholders who would be impacted by the implementation of the dashboard.

Initial stakeholders to be interviewed were selected by Dr. Chan and myself, according to the individuals who we knew would have a vested interest or be impacted by our project. A few additional suggestions of interviewees were provided by some of my committee members and through snowball sampling. These interviews were conducted to better understand:

1) How our tool could help other end-users, sometimes indirectly. This included end-users other than faculty members themselves.

2) How to design the tool in a way that would align with McMaster's business operations (e.g. P&T reviews, Merit reporting)
3) What challenges we could expect when designing this dashboard.

Interviews were conducted by myself over Zoom and lasted between 20 – 60 minutes. Interviews were documented in memos to take note of key points. Notes were stored on my personal laptop and summarized into short memos. Basic information on stakeholders (name, role, department) were documented in an Excel spreadsheet. Interview data was organized into a table highlighting emerging themes and how these themes present themselves in the current state of faculty data management (e.g. gaps and challenges) versus the future state (ideal state and future obstacles).

Phase 2) Design and Construction

Design

The information gathered in phase 1 was translated into initial requirements for the dashboard. I developed personas and use cases for how the application and dashboard will be used by various user roles and disciplines within Health Sciences. Personas helped assure that I built the prototypes with the end-user in mind. In this way, fictional characters were devised to represent the faculty members, each with varying characteristics, so that the needs of the end-users could be visualized during the design process.[56] Similarly, constructing use cases aided the design process by outlining the end user goals and ways in which they will interact with the system. This provided another opportunity to consider the viewpoint of the end user, thereby ensuring the design would satisfy the end-user needs.

After identifying the types of data required for our reporting purposes, I then focused on how to best present this data on the dashboard. All of the dashboard elements identified in phase 1 through stakeholder interviews, literature review, feedback study and document analysis were reported into an Excel table as initial dashboard requirements. I prioritized different elements according to whether they aligned with the objectives and purpose of the dashboard.

A variety of blogs and papers written by UX experts were consulted for tips and guidelines on how to create an optimal dashboard design.[47,48,60,65,66] I made sure to follow many of the cited standard best practices that are universally relevant across all design work. For example, I tried to make certain features standardized across the system. Toolbars, navigational tabs, filters, and other common components were kept uniform on all pages. For information that carried more importance, this was emphasized through size, contrast, and page placement. Hyperlinks within PowerPoint slides were used to simulate the interactive components of a functional application, thereby providing a demonstration of how a user could navigate through the system. These links allowed for a demonstration of clickable buttons, opening and closing of additional windows, toggling, and general navigation through the system. Charts and graphs were created in Excel using fake data to create example visualizations. Some infographics were created in an online design program, Canva. Icons and images were taken from stock image websites. In order to align with the McMaster brand, I utilized many of the recommended fonts, colour schema and icons from the McMaster branding website.[67] To allow for the anticipated large number of revision suggestions and requests for new additions, my early designs included more blank space. This would give me more room to quickly make these changes without having to reorganize the entire structure.

Construction

The first version of the prototype was created using elements from the initial requirements. As the design work involved several iterations, wireframing was done on Microsoft PowerPoint. This allowed for easy manipulation of the design, which was required to complete the rapid revisions as part of the design-based framework of the project. Each new revised prototype was saved on my personal laptop to keep records of all versions.

Phase 3) Evaluation and Reflection

Evaluation

During the evaluation phase, I had faculty members walk through the prototypes to explain their likes and dislikes, what they find useful, or what they would like to add or change. I then cycled back to phase 2 so that I could use these suggestions to revise the prototype, before going through phase 3 again.

Focus Groups and Interviews

Focus groups and interviews are two frequently recommended methods of evaluation for design projects.[54,58] There were 3 phases to the evaluation and revision stage. Each phase chunked together feedback sessions, with revisions and iterations in between. The first 2 phases included focus groups and interviews. In the final phase, a video walkthrough of the prototype was emailed out to participants. A Google Form was provided for participants to provide any final comments or feedback.

Focus groups and interviews were used to gather qualitative data on end-user perceptions and feedback for the prototypes as part of the evaluation and revision phases of the DBR project. This provided the opportunity to present prototypes to participants, gather their impressions or feedback, and use these suggestions to improve the prototype design. Multiple iterations of re-design and feedback was conducted. After the required changes were made, the next round of focus groups could be conducted to present the new prototype and gather more feedback.[54,55]

Focus Groups involved forming small groups of individuals, "brought together to discuss their experiences or opinions around topics introduced by a skilled moderator who facilitates an open, non-judgemental atmosphere." [54] The benefit of focus groups was that it stimulated dynamic group discussions. Group conversations elicited new thoughts and ideas in others, incited by hearing other participants' points of views.[54] To encourage rich discussion, focus groups allowed for a combination of participants with different roles and specialties. In addition, interviews were conducted 1-1 with participants. Not only did this provide more flexibility with participant schedules, but also allowed for more focused discussions on that faculty member's needs pertaining to their specific roles.

Reflection

After each focus group or interview, I logged both the perceived and unperceived revisions in a change request log. Perceived needs were those that were explicitly stated by participants. Unperceived needs were speculated by reading between the lines of what was articulated, empathizing with faculty, and forming interpretations on participant requests. Upon arrival at the final prototype version, I reflected on the final design and end-user feedback to summarize

various recommendations for the actual construction of the application.

Study Setting and Population

McMaster University's FHS was selected as the case study for this study. FHS is home to a broad range of departments, divisions, and programs and is responsible for the training of a variety of health professionals. The FHS provides education to a variety of healthcare professional programs for various levels. The faculty is comprised of 3 schools (School of Nursing, School of Rehabilitation Science, and DeGroote School of Medicine) and offers over 40 programs across undergraduate, graduate, postgraduate, and clinical learner levels. The McMaster FHS Department also includes Faculty members in various departments in roles including researchers, teachers, clinical educators and administrators. The Department employs faculty members with different appointments spanning full-time, part-time, and adjunct faculty members with varying levels of tenure, contract, and session work.

Participant Recruitment

Potential participants for the focus groups and interviews were compiled with assistance from Dr. Chan, as well as a few suggestions from Dr. Lokker. Participants were selected to include a diverse cross-section of faculty members in the FHS. Purposeful sampling was used to ensure inclusion of participants from various roles (clinicians, researchers, teachers, administrators/leaders), specialties (e.g. pediatrics, gastroenterology), departments (e.g. Medicine, Surgery, Psychiatry), schools (e.g. School of Nursing) and position (assistant

professor, associate professor, and full professor). We ensured our participant pool included an equal distribution of faculty members amongst various ages and genders. When identifying participants, we specifically considered the perceived technical literacy and experience with faculty development in participants. The aim was to create a diverse group with different levels of these characteristics. Participants with these characteristics were inferenced based on the thesis supervisor's network and previous encounters with these faculty members.

Invitations to participate in the focus group were sent through an email with an infographic (Appendix C). $100 Amazon gift cards were offered as incentives for participants who participated in all phases. Participants were directed to sign up for focus groups and interviews via an online scheduling program, SignUpGenius. Email reminders were sent to participants 24 hours prior to the session. A disclaimer was included to advise of the recording and use of de-identified quotes in the final report.

Data Collection and Analysis

Study Procedure

All elements of data collection and analysis in this study are illustrated in Figure 2.

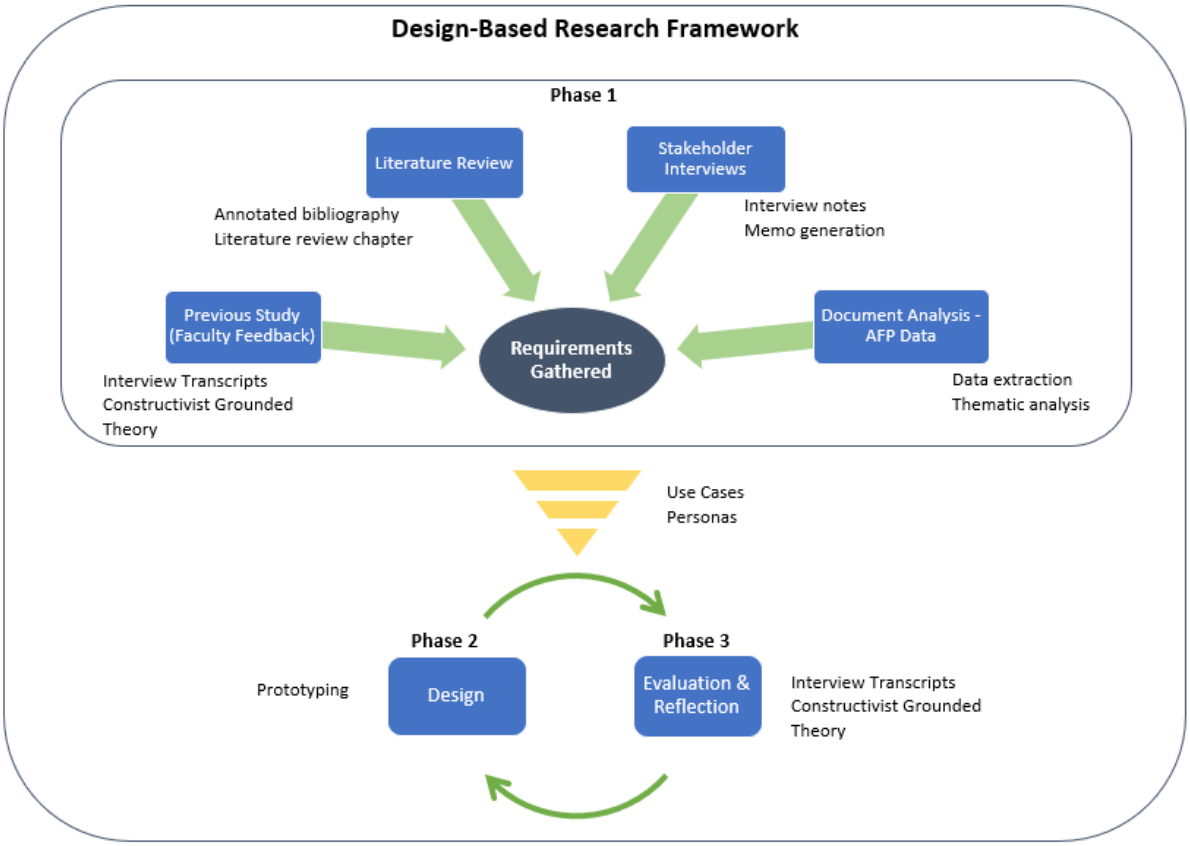


Figure 2: Overall Study Design

I used a constructivist approach to triangulate the results from all of these data sources to inform the design and analysis of my faculty dashboard prototypes. Constructivism in research assumes that there is not a single source of truth, but rather argues that the uniqueness and personal experiences of each individual attributes to their generation of knowledge and understanding of the world.[68] When creating a product like a dashboard, there is no right or wrong way of creating the design. There is no single truth for how the design should look, this would represent a positivist approach. Instead, there could be multiple ways of creating the design, and users will each have their own unique interaction and experience with the product.

Therefore, my goal was to gather a list of all possible data elements and then explore multiple ways of designing the dashboard. In doing so, I interacted with the data to explain concepts and formulate meanings and insights.[62]

Data Collection

Stakeholder Interviews

Stakeholder interviews were summarized into notes on my personal device. The document analysis involved note taking and charting of descriptive statistics into an Excel spreadsheet.

Document Analysis

Qualitative and quantitative data from previous year AFP documents and an R4 document were acquired through the Department of Medicine Chair's Office, with an understanding that all data would be kept confidential. These forms were blinded to maintain confidentiality of faculty members. These documents were stored on my personal computer in a password-protected folder.

Literature Review

An annotated bibliography was created to summarize the primary results of the literature review. Notes were made to outline the main importance and relevance of each resource to the project.

Focus Groups and Interviews

Focus groups and interviews were conducted over Zoom. Informed consent for audio recording and use of de-identified quotes in my report was obtained prior to conducting focus groups. All sessions involved walking the participants through the prototypes and then asking open ended questions about what they saw. Questions were asked such as 'what do you like or dislike about this page?' and 'what are your thoughts on this section?'. All sessions were recorded to the Zoom cloud and transcribed using the Zoom transcription feature. Transcripts were then revised and amended for accuracy. All transcripts were de-identified to remove names. Transcripts were stored on my personal device in a secure folder.

Data Analysis

Triangulation

Results from the stakeholder interviews, faculty feedback study, document analysis, literature review and focus groups/interviews were logged in an Excel table. The table was categorized by dashboard element and associated faculty need. For each element, I marked off where this element was identified or referenced (e.g. explicitly stated in an interview, extracted from the literature, included in forms from document analysis). In this way, I triangulated the data acquired from each method to develop a list of prototype elements and design requirements.

Constructivist Grounded Theory Analysis

The qualitative analysis of focus groups and interviews was conducted using a constructivist grounded theory approach (CGT), a method used to analyze qualitative data in an explorative manner, which can then form new conceptual ideas. The data was reviewed and coded according to key themes. CGT research allows for the evolution of a coding scheme, which can be refined as the analysis phase progresses. In this way, grounded theory involved developing new themes, allowing some themes to be absorbed by others, and then re-organizing the schema so that the results could produce insights.[69–71]

Transcripts were thematically coded by myself and 2 post-doctoral fellows (YY, SH), both of whom have extensive experience in qualitative research. A hierarchy of codes was created according to trends and overarching themes as identified in the transcripts. All three of us met to code the first 2 transcripts together. The remaining transcripts were coded individually by myself. Check-ins occurred periodically over emails or meetings to discuss transcripts or codes that required further verification. Discrepancies in quote interpretation and codes were resolved by group discussion. The initial coding was done in a Google doc. After all transcripts had been coded, the coding team (VM, YY, SH) and my thesis supervisor (TC) met to assess and re-organize the codes. A free, online whiteboard tool, Miro, was used for the final coding re-structure. At this point, all members were satisfied with the output, and this structure was used as the final coding scheme.

4. Results

Literature Review

Key resources that I used to inform my project are summarized in an annotated bibliography (Appendix D).

Stakeholder Interviews

A total of 10 stakeholders were interviewed. Four of these stakeholders were female and six were male. A breakdown of the participants who were interviewed are listed in Appendix E.

These interviews generated insights on the current and future state of the problem (Table 1). I recorded the main takeaways from these interviews in my own personal memos. I met with three different administrators to discuss the process faculty members undergo for promotion and tenure and annual reviews. These interviews helped me identify the required documentation, assessments and milestones that faculty members must complete in order to be promoted. Challenges associated with the capture and reporting of faculty data as well as additional suggestions for the dashboard were brought forward during my meetings with the department manager and financial stakeholders. Meeting with IT experts allowed me to understand the current and future state of faculty data management at McMaster University, which provided insights for the technical considerations and challenges that should be considered in the build of the dashboard, all of which would guide future work that could emerge from this project.

Finally, I spoke with a faculty member and a student who had begun building a similar application and dashboard for instructors in one of the FHS schools. Their application was more focused around course instruction for a particular program. Viewing and discussing their application prompted me to consider how my dashboard could potentially integrate with their system. While their dashboard was at a much smaller scope than what my dashboard was hoping to achieve, it was helpful to see what related work was being done to address a similar problem.

Table 1: Current and Future State of Problem

	Current State (Gaps and Challenges)	Future State (Opportunities, obstacles, ideal state)
Overall Faculty data management	● There is currently no enterprise system available (at McMaster or commercial) that can effectively collect, manage and report FHS faculty data. ● There is a general lack of strategy for who has access to faculty data, who owns it, or who controls it. ● There are many lost opportunities by not digitizing or analyzing pertinent information.	● Various stakeholders will find some value in a product that can effectively capture, analyze and report faculty data at McMaster. ● Data governance and privacy will continue to be important and challenging. ● Aside from the benefits discussed in the background here are other opportunities that would emerge from a faculty dashboard. For example: ○ Reporting of aggregated faculty information (e.g. gender, degree, ethnicity) for accreditation purposes ○ Reduce data entry errors (by eliminating duplicate data entry points)
P&T/ Annual Reviews/ AFP and Academic Merit Reporting	● Each FHS department handles P&T slightly differently, but all follow the same University policies. ● There is a lot of manual and onerous work performed by the faculty member and administrators to compile and report data.	● P&T and annual reviews involve reviewing all contributions and achievements of a faculty member over their career. If this could be done in the dashboard, it could help support this process. ● Allowing for more efficient data collection methods (e.g. data scraping methods, better flow of

	● Often faculty are missing data when they are up for P&T or reporting for Merit.	information between systems) could help make processes more efficient.
Technology/Back-end	● There are currently many different systems that house data at McMaster. ● There is little interoperability amongst these systems. ● Most faculty data is manually entered into MacFACTS, where it goes into the Star Database.	● There needs to be a single source of truth for faculty data; there should be one designated system which owns, stores and edits the data. The data can be shared with other systems, rather than stored as duplicates. ● Work is being done to develop a central FHS database which would compile data from multiple systems across campus. This would replace the Star Database. These efforts could augment the work of the dashboard design because this new database could potentially serve as the back-end system that collates and analyzes the data that could populate the dashboard as the front-facing interface. There may be an opportunity to integrate a version of the dashboard as a plugin for this FHS system, thus reducing the workload of creating a new database.

Document Analysis

With support from the Department Chair, 9 AFP forms in the Department of Medicine were provided for my study, all de-identified by omitting any personal identifiers. Document samples were from 2019 and included a cross-section of faculty members with various levels of tenure, different departments, and different areas of focus (e.g., clinical vs. research) to ensure

that the collection was as representative as possible. An approximate equal number of male and female faculty member forms were provided.

The AFP forms are Excel spreadsheet templates with fillable sections for the faculty member to populate. Forms also include columns for the divisional mean values to be added. Reviewing the AFP documents provided a long list of potential metrics that are used in the Medicine merit system and are required for reporting purposes. Forms demonstrated that faculty contributions in Medicine are categorized into nine categories, as listed in Appendix F. The weighted values of activities in each of these categories are used to calculate global statistics, including total education hours and total research points. High-level statistics from the forms are provided in Appendix F.

This analysis allowed me to get a sense of the typical numeric ranges that could be used as sample data values in the prototype, which could make it appear more realistic and relatable for the study participants. Studying the AFP forms also led to a greater comprehension of how faculty data reporting can uncover valuable insights. Data aggregated from AFP forms could demonstrate the allocation of time and effort dedicated towards different areas within the Department of Medicine, such as research or undergraduate education. Merit reports such as AFP forms can reveal which areas faculty are most productive in, which can be insightful for faculty as it allows them to report and reflect on their activities, which can translate into monetary rewards through merit payments.

A sample R4 document was also reviewed as part of the document analysis. The R4 breaks activities down by Education, Research, Health Services/Clinical and Administration. These forms are created specifically for each faculty member to allocate their time in each of these categories, with a total allotment adding up to 100%. Reviewing the R4 was helpful for me

to see how FHS categorizes scholarship and the different types of roles that would be included in the R4.

McMaster policies were also reviewed to provide context around some of the processes that take place at McMaster University, with particular attention to P&T. The policies reviewed and their relevance to the study are provided below in Appendix G.

Design Requirements

Use Cases

Many software development experts recommend the creation of use cases to help demonstrate the functionality of a system from the viewpoint of an external party, named the actor. Use cases demonstrate the various ways in which the actors will interact with the system, including all of the actions and steps that they will perform.[72]

For the faculty dashboard application, there are several actors who interact with the system, the primary being the faculty members themselves. Other systems, both McMaster owned and external, would be involved through transactions where data would be pulled from these systems into a database which would then be used to populate the dashboards. While the technical aspect of this data integration is extremely important and will require a great deal of work and planning, this is outside the scope of this project. The actors of interest are the people who will be viewing and navigating through the dashboards. The features of this human-computer interaction are described in the use cases found in Appendix H. These use cases were

contrived based on the role of the end-user as well as the respective purposes for using the dashboard.

Personas

Many software developers, UX experts and designers recommend that personas be developed prior to the initiating the design or build of a solution. [54,56,58] The numbers of suitable personas will vary between projects, but the purpose is for the designer to enhance their understanding for the users and to serve as an "exercise in empathy".[56] For this project, I created four personas for each of the main faculty member roles (clinical educator, researcher, teacher, leader). Appendix I displays the personas that were created.

Personas were created to incorporate varying levels of technical skills, as well as different needs, pain points, tenure levels and personality traits. Personas were inspired by my own personal experience working with faculty members, as well as the participants who I interviewed as part of the previous feedback study. Creating the personas allowed me to consider the variation in scholarship and what is valued across different roles and specialties. This helped me consider the data and visualizations that I should include in my dashboard so that it could suit these different personas.

Design Elements

Design elements, features, and types of data that were identified through the various channels of requirements gathering are summarized in Appendix J. A large number of potential

elements were identified. While there were many potential features that were cited, these needed to be prioritized in order to determine which could be fit into the dashboard, as well as which should be more prominently displayed. Some data elements were common to all faculty members (e.g., information about promotion and scholarship), while some were discipline specific (e.g., clinical teaching information). The 3 categories with the largest number of data elements included research activity, data for merit funding, and teaching activity. Some elements were consistently mentioned and valued across all user participants in the study. Contrarily, there were several needs that only 1 or more participants requested, while others were either indifferent or opposed. These differences in opinions sometimes varied by role, level of career and individual preferences. For example, researchers naturally wanted to see KPIs associated with their research activities (publications, citations, reviews, h-index). Those in other roles with less of a research focus often did not want to have these numbers predominantly featured. Clinical educators were more interested in the quality of feedback that they provide to students, compared to teachers, researchers and administrators. There were also some trends relating to the level of career. More junior faculty members appeared to be more interested in elements related to goal-setting, formative feedback and suggestions of future opportunities. Mid to late-stage career faculty members were more inclined to want features that could help them prepare for promotion, annual reviews or AFP reporting.

These data elements would come from multiple inputs, including both McMaster internal and external systems. Figure 3 summarizes the various data inputs that could potentially be used for our database.

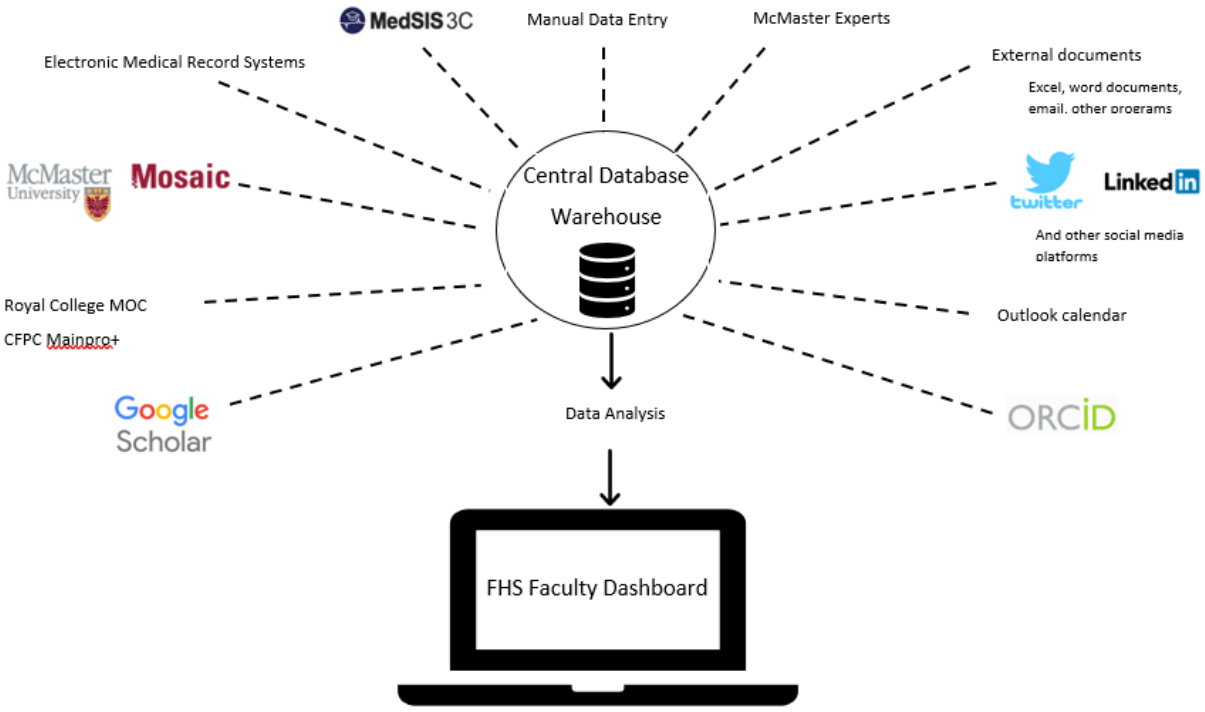


Figure 3: Data Inputs for FHS Dashboard

Prototypes

Walkthroughs of the final versions of the prototype can be viewed in the following video - https://youtu.be/zrkm5eRYECw. The dashboard incorporated both narrative and numerical data and data visualizations. Data elements from a variety of systems (e.g. MedSIS, Google Scholar) and evaluators (students, colleagues, managers) were included. Different user groups were created to account for the various users who would be logging into the system (Figure 4).

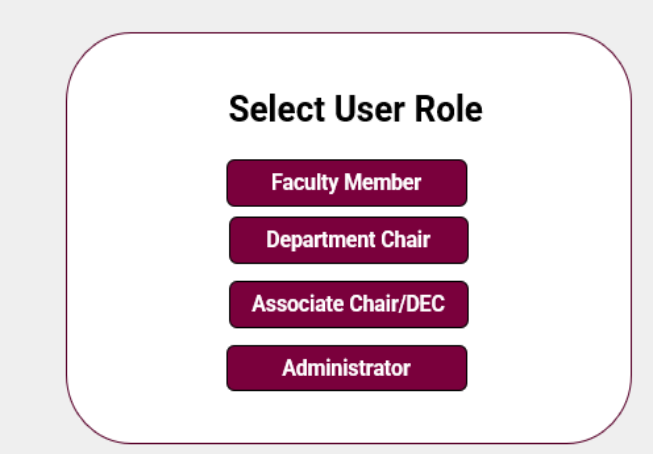


Figure 4: User roles

The amount of faculty data identified during the requirements gathering was very large. The challenge was prioritizing the data that should be included on the dashboard, while categorizing other 'nice to have' types of data that were not a priority. Considering the extensive list of potential dashboard elements identified in the exploration and analysis phase, it was important that I carefully select those that would align with the objectives of the dashboards and meet the needs of the end users. Not all could be selected, otherwise they would not fit onto a single dashboard screen or result in cognitive overload on the user from seeing too much information.[52]

Results from Focus Groups and Interviews

Demographic Information

A total of 18 faculty members participated in the focus groups and interviews. There were 12 female and 6 male participants. Table 2 displays the demographic and appointment information for the participant pool.

Table 2: Participant Descriptive Statistics

Gender	
Female	12
Male	6
Role	
Administrator/Leader	12
Clinical Educator	12
Researcher	11
Teacher	5
Department	
Family Medicine	1
Medicine	7
Health Research Methods Evidence and Impact	2
Pathology & Molecular Medicine	1
Pediatrics	2
Psychiatry	1
Surgery	2
School	
Nursing	1
Rehabiliation Science	1
Appointment	
Associate Professor	7
Assistant Professor	7
Professor	3
Postdoctoral Fellow	1

A pilot focus group was conducted with 2 faculty members who were co-supervisors for the project (TC, YY), providing me with the opportunity to practice facilitating the focus groups. Following the pilot sessions, 3 phases of prototype evaluation were conducted. The first 2 rounds included focus groups and interviews held over Zoom. The prototypes were displayed through screen sharing to allow participants to view and provide feedback on these prototypes.

In the first phase of feedback, 3 focus groups were held, each group had 3-5 participants. 2 additional sessions were conducted 1-1 with faculty members who could not attend the other focus group dates.

The first round of focus groups were structured as follows:

- Welcome and housekeeping: Obtain consent.
- Group introductions: Asked to introduce name, appointment, position.
- Provide overview of project, explain purpose of dashboard, define faculty data.
- Demonstration of prototypes and discussions.
- Closing.

A combination of focus groups and interviews were conducted with participants during the second phase. Nine 1-1 interviews and 2 focus groups were conducted, including 10 individuals who also participated in the first round. Minor to more significant revisions were made to the prototypes between each interview and focus group. After the first 2 phases of evaluation and revisions, video walkthroughs of prototypes were distributed by email to participants for any final comments or suggestions.

Over the course of focus groups and interviews, even more elements were brought forward and the prototypes continued to evolve significantly over the course of the study. In the

final rounds of feedback, there were little to no suggestions for additions or revisions or additions to the dashboard. For the transcript analysis, we reached a state of theoretical saturation. At this point, the analysis of transcripts did not contribute to new themes or insights.

Thematic Analysis

The thematic analysis of focus groups and interviews using a constructivist grounded theory methodology revealed 4 main, overarching themes: Faculty appointment; User groups; Front-end design elements; Concerns and challenges. Within the front-end design elements theme, there were 2 sub-themes for general elements and specific requirements. The themes and sub-themes and how they pertain to faculty member needs for the dashboard design are described below. Each of these themes encompassed several valuable insights pertaining to faculty member needs for the dashboard design.

Faculty Appointment

Participants in our study represented the variability of users who would be using the dashboard. Faculty come from different departments, have different types of appointments, and each has their own set of role(s) as outlined in their R4. The final prototype organized some of the dashboard pages by the different R4 roles: Teaching, Research, Administration, and Clinical Service. Participants frequently made reference to the R4 and felt that it was important for the dashboard design to align with these roles. The majority also wanted their R4 breakdown to be embedded in the dashboard for them to use as a quick reference:

> *"I was filling out R4 stuff and I'm like where is my R4 document, what was my time split, so this is nice to just have it all in one place, I really like it."*

An additional layer to faculty users comes from the different types of appointments they hold, their tenure, track, and rank. These variations in roles and appointments are what make up the distinct faculty phenotypes, some of which have their own characteristics and needs for the dashboard. Different phenotypes in our study had some contrasting opinions and preferences for how they wanted the dashboard to be structured. One participant described this phenomena:

> *"You know, exactly the same with the categories, that will look different. Like, for example, I wouldn't know what it means, as a part-time clinical faculty, what it means to be teaching courses. I think that applies more to maybe undergrad students or you know master's degree students. For me, I am a faculty developer and I do the occasional clinical teaching, so I don't think those will count at all. So things might need to be organized differently depending on what the prototype of the faculty members is."*

For this reason, certain features of the dashboard were envisioned to be customizable so that the more relevant elements would only appear for certain faculty phenotypes (e.g. only those who teach classes would see KPIs on classes taught). Additionally, a separate clinical teaching tab was created with elements that only clinical educators wanted, thus making it easy to hide these features from non-clinician dashboards.

User Groups

Multiple user groups will need to be classified in the system in order to account for the different faculty positions and their respective purpose for using the dashboard. Many agreed that there should be separate levels of access, views and privacy settings for the types of users. One participant articulated:

> *"It should be applicable and available to all and everybody has a different view of it. You know, as a Faculty Member, you may have one view but as your chair or your [Departmental Educational Coordinator] I may have a different view, which is again curated to what is important is what my role is."*

Participants who belong to each of these user groups had divergent opinions on what they wanted included in their dashboard view. While some features or characteristics were common across all types of user groups, such as learner evaluations, some features such as global departmental statistics would only apply to Deans and Chairs.

Front-end design elements

General Elements

The front-end design elements category contained the most number of sub-themes. These elements identified and described several requirements for the interface and functionality of the dashboard. Several general elements were mentioned, representing the features that are often universally applicable for any good dashboard design. Users want the dashboard to be dynamic, comprehensive, visually appealing, customizable, flexible, interactive, and include different levels of granularity in the data. These characteristics were not surprising, as they are commonly understood as best practices in dashboard design. Participants expressed an interest in having the dashboard as an aesthetically pleasing, 'one-stop-shop' for all of their academia and goals:

> *"I think it has all of the very pertinent information that, if I can just- if I have five minutes and I need to capture something my dashboard has it all, which I think is just great. So I really liked the look."*

For the dashboard to be useful, it should be relevant to the faculty member's specific appointment details. Other common dashboard features that were valued included alerts that could provide notifications of upcoming events or deadlines, the ability to generate and export various types of reports such as teaching dossiers or CVs, as well as dashboard help functions to provide context, definitions or explanations on the data and how to interpret it.

Many participants alluded to data inputs and how information could be streamlined from other systems. In response to participant suggestions, I added a link on the top toolbar to a data entry interface where the user or delegate could enter additional data to the system, as well as automated data inputs from other sources. Many participants also raised the issue of the multiple, disparate systems where data exists at McMaster, and felt that collating this information into the dashboard would be beneficial:

> *"Off the top of my head,...we're looking at MacFACTS and how they calculate each of the MacFACTS hours. Then we're also looking at all the ways that we capture teaching, so MedSIS... as well as teaching in classrooms, undergrad students, grad students. All of these are streams of information that are housed in different places, right now, and we can have a better interface between all these different streams and to create a dashboard."*

Specific Requirements

Several other front-end design elements were discussed which encompass the needs that are more specific to the type of dashboard and users in question. Three sub-themes were categorized under specific requirements. These sub-themes which represent 3 purposes of the data are summarized in Appendix K.

Sub-Theme 1) Reporting for Insights

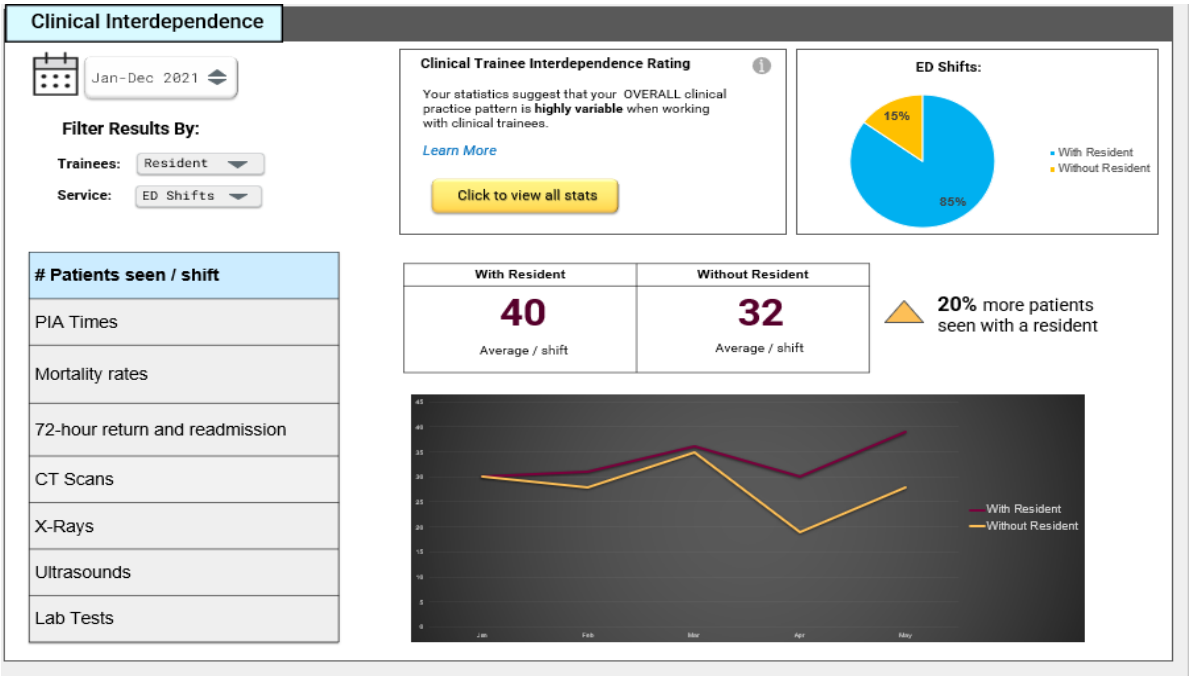
Features in this category include the dashboard elements which contribute to the generation of insights. Insights are the unexpected findings or newly discovered patterns that are extracted through data analysis. This refers to the visualization of information in the dashboard in order to extract meaning and lead to a deeper understanding of the data. [44] Therefore, this sub-theme includes information such as the different research/scholarship projects a faculty member is currently working on. Visualizing this data in the dashboard can create new insights for faculty, such as revealing a particular area of research focus that was not otherwise perceived. This is just one example within this theme where faculty members could use the dashboard reporting to unveil purposeful insights, which can letter to a better understanding and improvement in their performance.

Participants wanted to be able to view their past and upcoming activities across all roles, including education, clinical teaching, research and administration. Further, participants also felt it was important to see their continuing professional development (CPD) activity, resulting in a new dashboard page created to serve this purpose. This was particularly valued by physicians, who have minimum thresholds of CPD activities which they are mandated to complete by their respective medical college (e.g. Royal College of Physicians and Surgeons of Canada, or the College of Family Physicians of Canada). For all of these activities, there is a desire to highlight the breadth of all the different experiences. This information, coupled with other types of assessments, could be used to provide an accurate representation of performance and progress.

While participants wanted most of their activities and performance analytics reported in the dashboard, visualizations of clinical performance was one exception. Figure 5 shows an early version of a clinical interdependence dashboard, showing the comparison of clinical performance

measurements with and without a medical trainee. The majority strongly opposed including this page in the dashboard. Mistrust of the data, concerns about the interpretation, and general lack of interest were some of the reasons for this negative response. This paralleled with similar concerns from my previous faculty feedback study, whereby many faculty members were cautious about clinical data reporting and variable interpretation of data, particularly when they lack context and differ between physician specialties.

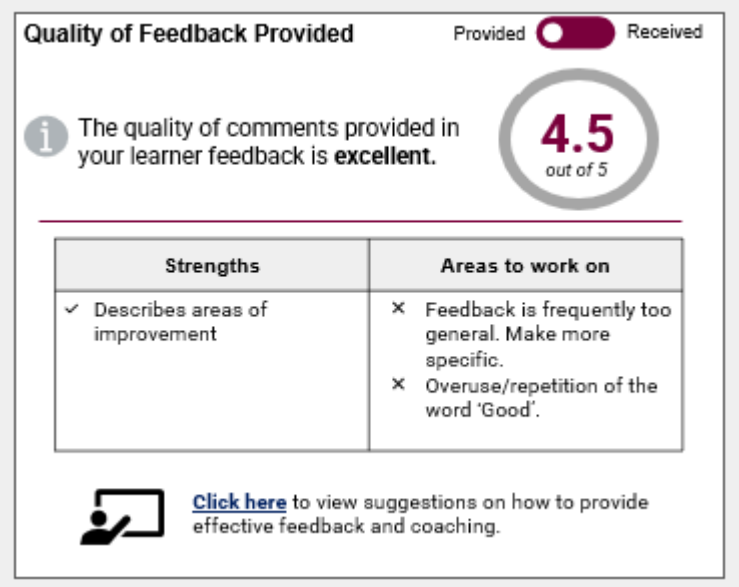
Figure 5: Clinical Interdependence Dashboard



Participants wanted to see not only the number of learners they had worked with, but also the diversity of learners, nature of interaction, and impact of the teaching. Clinical supervisors were interested in seeing the quality of the feedback that they provide to learners through

assessments such as EPAs (Figure 6). Moreover, being able to see learner achievements helped faculty members discern whether they were "successful as a supervisor".

Figure 6: Quality of Feedback Score



Finally, information about a faculty member's network was valued. In addition to more traditional collaboration through research, participants regarded social media activity as a useful input that would provide valuable insight about performance.

> *"I am very active on Twitter so yes, I like it. I actually do think it's valuable. Certainly, [it] hasn't been traditionally... captured in other ways. And yet I think it creates more indirect influences in that people recognize your name and then you do get invitations to do talks and you, you know, you do get invited into conversations and whatever, and those are helpful. But it's also nice to have, right, because we all like- there is evidence now saying that if your papers are talked about on Twitter, that you get more citations, like it does start to tie in."*

The insights listed are applicable at the individual level, both for the faculty members themselves, and for leaders. For those in leadership positions, viewing global statistics about the greater faculty group, such as the distribution of gender, age ranges or ethnicity are required for accreditation purposes. Also, this information can help direct change and business planning in a department, should certain trends arise from the data.

Sub-Theme 2) Data for reflection and analysis

The second sub-theme included data that would facilitate further analysis and reflection by the faculty member in ways that could be useful for purposes such as career development, personal growth or planning. Elements such as 360 evaluations and comparative metrics could allow faculty members to obtain purposeful extractions about themselves and their performance. One participant described how the dashboard could facilitate deeper reflections. They used the wellness assessment element as an example:

> *"Is there a way for [users] to also be able to reflect on how they're doing from their wellness? Almost like a burnout or wellness meter...you can have people rate themselves and then take a look and see how that goes as they're coming closer to achieving their goals. Is wellness and burnout kind of making its way differently as you're kind of far away from your goal vs. closer to the goals that you've put out for yourself....Maybe this is my way of going and speaking with my division leader or my associate chair to say, this is all the stuff that's on my plate, these are my goals, I'm feeling burnt out."*

This element along with others, were often referenced in respect to goal-setting by the faculty member. The ability for the dashboard to facilitate the creation and tracking of personal goals was deemed to be very valuable by many of our participants:

> *"I really like the view on personal goals, I think it's nice to highlight what we think is of importance, and this gives us - It kind of grounds us into this is where I'm trying to go,*

and this is kind of why and how. And then you can use the other tabs to kind of help you get there, so I think that's great"

Several other examples of dashboard elements that could prompt reflection or goal setting were described, many of which are likely to have positive effects on the user's performance and self-awareness, such as learning whether they are meeting or exceeding expectations. Participants were also intrigued by the possibility of computer-assisted recommendations, which could help the dashboard provide more of a platform for coaching and continuous improvement, in addition to the coaching or mentorship obtained from colleagues.

Sub-theme 3) Archival of achievement

The archival of achievements for summative assessments refers to data on the faculty member's activities and achievements that can be recorded and displayed in the dashboard for various reporting purposes. Many participants were keen to have the dashboard help support many of the administrative processes that are otherwise onerous or confusing. Many wanted the tool to help facilitate the annual reporting for Academic Merit Funding, as described by one participant:

"Anything to make that easier, because it turns into it's like tax time. You sit in your office for days being like, how do I capture all the things that I've done? And if you can do it maybe a little bit more frequently or update it on a monthly basis, theoretically that sounds better. But I really like this because it's very intuitive to me that this does capture all of your academics and education."

Participants recognized a need for the tool to both facilitate the data capture and compilation for the Academic Merit Form form completion (e.g. AFP forms), and also to have the organization of the dashboard align these documentation standards. There is a lack of clarity

amongst many faculty members on how Merit is calculated. Participants expressed a strong desire for the dashboard to provide more transparency about how their data is translated into monetary outcomes.

> *"Some of the stuff...I have to enter into my record of activities annually...So I wonder if the categories that are represented under the record of activities can be linked to because something I'd be curious to know is, when it comes to Merit pay, for example, I get ranked. I have no idea how I compare. And that's calculated based in part on that record of activities and those specific numbers that we have to enter in. So I'm wondering if there's some way to create some more alignment between that form and this."*

In this way, participants wanted the dashboard to provide visibility around the weighting of activities so that they could have more robust definitions around what types of activities or levels of performance are deemed as meritorious. This would then be "*much more defensible in terms of how that money gets allocated."*

Much like Merit, the dashboard should support the process of P&T and/or annual reviews. Several participants stated that this would be the primary reason they would want to use the dashboard:

> *"But then I guess that probably goes to the purpose of it, I mean from for me anyway, one of the purposes of this would be because I was putting something together for the next promotion level...I mean we have our annual [review] for my department...I could look at this as a snapshot to be able to filter down from the date range, okay, this was my activities, just making sure everything was in alignment before my annual review and the forms that I have to fill out for that review."*

Essentially, the dashboard could help faculty highlight everything they have done, as well as provide guidance around the requirements for being promoted. Having elements in the dashboard such as teaching mission/philosophy could help the faculty member prepare for their

promotion review. Additionally, those in leadership roles who are involved in the P&T process felt that the dashboard and CV builder feature would be useful from their perspective.

> *"...it would give the individual who's reviewing them, whether it be myself or someone else for reappointment a promotion, to be confident that I have an updated CV that they've vetted that can show their activities."*

In regards to learner feedback, participants found the Teaching Effectiveness Score (TES) page to be useful. Those in leadership roles valued having the Overall TES Score prominently featured. On the other hand, the TES data can be interpreted more effectively when additional context is provided (i.e. response rates, breakdown by course, type of learner).

> *"And I think the overall TES is good, but it would be interesting to see how the TES's are, if they are, different between the different groups or populations of learners so is the TES much different when they're supervising undergrad learners versus postgrad learners or graduate students, I think that would be helpful."*

In addition to achievements such as awards, participants felt it was extremely important that the dashboard highlight the innovative work that falls outside the traditional realm of professorship. A number of participants described different initiatives and accomplishments that they want to ensure are visible and valued.

> *"So for me, some of the pedagogical innovations that have been on there is that we've created curriculum...So different curriculums that fall outside of courses that I would normally teach, but have an impact on different learner populations within our University."*

In addition to pedagogical innovations, faculty also wanted to ensure that all of their service was highlighted, including off-campus work and external roles held outside of McMaster.

> *"And I think that might be helpful to capture...specifically a way of tracking those kinds of internal service pieces I think are important. Then I would say the flip is- is there an opportunity for those also external pieces to be considered? So if I'm serving on the*

> *executive of a national conference committee or if I'm you know, serving on the scientific advisory board for something, or whatever, those pieces I think are also part of what we would want as our service, and I think are valuable to track."*

In a similar manner, non-traditional research activities and outputs must be included in the dashboard. Those with a primary research focus liked seeing many of the traditional assessments of research performance such as the h-index, publications, citation counts and grants awarded. However, concerns were brought up by others who felt that these measurements were not an accurate representation of their form of research. Some referred to their research as 'scholarship', and explained that instead of peer-reviewed publications, they might contribute in other ways:

> *"I think this is a deeper conversation [needed] to really sort of break down like what, what are the scholarly outputs that we do... things like doing stuff on social media, you know Twitter are places where you are disseminating knowledge and so factoring that in here I think needs to be done."*

Along these lines, participants wanted to see evidence not only of their research/scholarship productivity, but how they are translating this knowledge through various streams such as media interviews or online blogging. Thus, incorporating all aspects of a faculty member's work in the dashboard is imperative and can also ensure that their local and international impact are accounted for in annual reviews, P&T and merit assessments.

Concerns and Challenges

Participants frequently expressed an interest and excitement about the prototypes. As one participant stated, "I would pay for this". However, these positive reactions were sometimes met by some apprehension. Several faculty members cited concerns about the quality and accuracy of

data on the dashboard. The data itself may be skewed due to underlying gaps or biases that may not be outwardly apparent:

> *"The only one point I would just say on the quality of feedback, and the reason I think I mentioned this sort of validity evidence is that the one thing I am concerned about is that with the number of feedback things that potentially come on, I think it's important, but it also lends itself potentially to biases that are present and especially systemic biases. Especially when it comes to ratings and rankings and whatnot, that when you attribute and number to, it could be potentially discriminatory in a way. So that's why I would say that whatever system that gets developed…[someone] just needs to make sure that that is looked at and protected."*

There were also concerns about the weight and potential authority that this data may have, which would be particularly problematic if the data quality was poor. For example, low response rates from students might provide a TES score that is not representative of the faculty performance. The question was then how much the data in the dashboard could be trusted:

> *"How can people like me, at a glance, get educated about recognizing the quality of the data that's in front of me. Because some of the data is meaningless, a lot of it is. And so it's a lot of noise, but the real question is- so what does it actually say and how much confidence can I have in it to reflect sort of like face validity."*

This mistrust was also commonly referenced in relation to reports of time allocation. Dashboard elements which provided calculations or estimations of the distributed time spent across the multiple facets of scholarship were felt to be problematic since they were likely to be inaccurate. Many stated that it would not be possible for the system to accurately record the time spent across research, administration, teaching and clinical service. Hence, there were concerns about the impacts of relying on these measurements and the potential implications:

> *"...the accuracy, I think you will have to get a lot of feedback from lots of different division chairs and DECs to come up with something that people are going to trust. Because then this becomes problematic right, because if I see my education profile says 30% [time] in research...I say oh my god, I am doing so much research, I'm going to go*

> *up to my chief and say you know what you need to change my R4, I need to do a lot less education, because I'm doing so much research. That has implications on a full division because at the end of the day, there needs to be people who are providing clinical service, education and research. And if this is going to be my bargaining chip, then it better be a very accurate bargaining chip."*

Acquiring accurate scholarship allocations is also difficult because some work can be categorized across multiple roles. One participant pondered, "*If I go and talk about my research in a class to a course... I still think of that as teaching. But if I'm talking about my research rounds, is that teaching?"* The dividing line between the R4 categories is sometimes blurry, making this a more complicated element to implement. One participant verbalized this challenge:

> *"This is tricky, just knowing that there are so many things that interweave, I know I can count certain course time as that's teaching time, but some of my research and some of my stuff outside of those out of my teaching actually does contribute to my teaching and vice versa".*

Additionally, the organization and structure of data elements in the dashboard was more complicated due to the obscure definitions of some of the activities. This caused some difference in opinions around which pages (research, teaching or administration) that certain activities should be placed on the dashboard.

In addition to data accuracy, participants expressed a concern regarding the comprehensiveness of the dashboard as it pertains to their specific appointment. Some described how their position and activities are unique and were worried that their contributions would not be reflected in the dashboard. Faculty will feel concerned and frustrated to see gaps or holes in the dashboard for particular sections that are not applicable to them and would therefore not be populated with any information. This was a common concern in regards to the research page:

> *"Because I feel like I would be very, very disheartened if I came to this page as a clinician educator and then it was, like all empty. And no recent publications and my h-index is pretty low. Right?"*

In this sense, the dashboard could be confusing or distressing for faculty if they do not understand the data or their expectations.

> *"It's good it's going to be anxiety provoking for a lot of people. So, in some ways, you know, being able to create a context, because for many people they're thinking about, okay well how much of this do I need to get promoted to associate Professor [or] full Professor? So that might be interesting...did you know that on average, at McMaster, those who got promoted to associate Professor had X number of publications, X number of citations? Just to kind of create a context because this can create sort of... a data void for people and they get super anxious and what we don't want to do is have you know faculty be freaked out by [this]"*

The data must contain enough context to help faculty understand their expectations and how they are performing. To achieve this, I embedded prompts into certain sections of the dashboard that would link out to a page with additional information and guidance (e.g. "What are my expectations for research and scholarship activity?"). Participants also mentioned the potential for other negative emotions in response to the dashboard, which may be exacerbated if there is a notion that the data could be used for punitive purposes. Faculty will want to know who has access to their data, and how it will be used by leaders.

Further, the dashboard in this study relies on the ability to acquire data from other sources. As one participant described, *"In order for this dashboard, regardless of the format, to be successful, it will be necessary to ensure that the feeder information is robust."*.

While many liked the idea of having the dashboard pull information from other systems, there were several who anticipated that this would be a major challenge.

> *"Well, I think it's super interesting. My comment will be similar to what I mentioned before, about the input streams there are so many additional input streams here that- where you've gotten your data from internal FHS finance dashboards to external, so I think that that will be the biggest challenge in terms of how to actually get that data and update this dashboard on a regular basis."*

Thus, there was concern about the feasibility of pulling all of the data included in the design. Participants were also concerned about the time and effort needed to maintain the database or consistently validate the data for accuracy. This is an important consideration as faculty already have significant time constraints.

> *"I'm just going to echo the concern around time spent to keep this up to date. I mean the, yeah, the CV system has just…like you avoid it, you know what I mean. So that's like what I don't want this to become, a thing that people avoid until like the last minute and then it's like, oh my God, I like need to update this dashboard because that's not the point right? Like what you're trying to do is have something that people can update consistently and maybe just pulls information from different sources so there's like an element of like interoperability that needs to be built into the system. But yeah that's a concern."*

It was made clear that if the dashboard led to a significant investment in time and effort to maintain the data, this would lead to gaps in the dashboard and a low level of buy-in.

> *"It's going to be really like, no one will fill all this in that are too busy because they just don't have time and they just, they're deadline driven...So there's a danger in having too much detail here. That will lead to gaps and frustration I think, from say someone like myself as an administrator and wants to sort of look and see what's going on, they'll be like big holes in the data. So you kind of want to make it practical, useful and meaningful to people so they will engage. So that's just you know don't make it too much, it'll fail because everybody will just go- they'll say I can't do this, there's just- I need time with my family like I can't fill in all this."*

This affirmed the importance of automation in how the dashboard data is populated and pulled from other systems, so as not to overwhelm faculty with extra work.

Concerns around data governance and privacy were also prevalent. Given the richness and personal nature of the data included in the prototypes, this prompted questions around who owns the data, who has access to it, and who manipulates it.

> *"There's going to be a lot of data here, potentially. So if I'm paranoid, I would say who's got the governance over the data? And there may be, you know, most of this will be quite positive, there may be some negative stuff here. And if I'm a faculty Member that's maybe not performing as well as I should, I might not want to share that. But there's a bit of an obligation in terms of you are on faculty, you have an appointment, you know and for geographic full-time appointments, there's a bit of an onus to those that you report to and it's the buck stops with the Chair of the department. So I think there needs to be [some] idea and an agreement, and it probably needs to be fairly robust...Because [if] it works, it's going to be very rich. And so you know, there needs to be sort of a not a cone of silence, but a cone around this as to who has access. So that needs to be kind of really well defined."*

Especially for data that is less flattering, faculty will be apprehensive about this being viewable to others, including their Chair or Education Coordinator. A participant in this study who holds this type of leadership position was also cognizant of this concern:

> *"One is just confidentiality, so if you're going to include professionalism concerns there, you need to make sure that the Faculty is aware that this is available for leaders to view and that they're aware that this professionalism concern is on this dashboard so that it's not a surprise to them when the Faculty Member or when I contact the Faculty Member for the annual review and see that there."*

The permissions aspect is therefore very important. As one participant described, there will need to be tighter boundaries around particularly confidential or sensitive data. Certain sections should be more 'locked down' so that nobody except the faculty member could see it unless they approved the option to share it.

5. Discussion

I have outlined a Design-Based Research Project that integrated theory, design principles, and end-user feedback to produce prototypes for a web-based faculty performance dashboard. Through several iterations of design, evaluation, and refinement, I have outlined a framework that details important considerations, requirements and challenges for the overall structure of a dashboard that could be applicable for Health Sciences Departments (Figure 7). Grounded in User-Centred design, this project focused on the needs and wants of a broad range of users. Inputs from our users were collated and used to create the design for a dashboard that is capable of providing comprehensive and dynamic visual representations of performance data which could be used by multiple stakeholders (faculty members, chairs, deans). Other researchers may wish to build upon the results of our study or use our findings to develop solutions to similar problems.

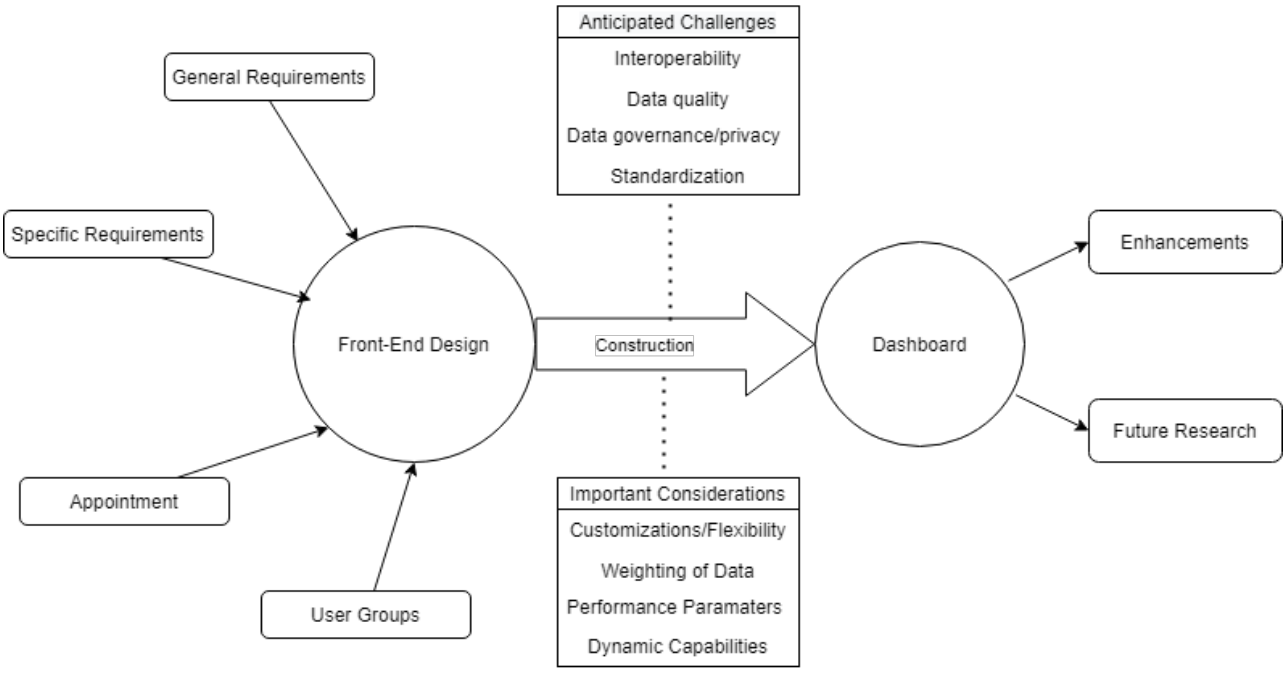


Figure 7: Key Insights for Developing a Faculty Dashboard

Faculty proposed many additions and new elements to the dashboard throughout the duration of the study. Participants expressed a lot of enthusiasm over the dashboard prototypes, signifying that these dashboards are both desired by faculty members and needed to fill existing gaps. It was discovered that faculty member needs vary greatly depending on their role, specialty, stage of career, and individual preferences. The purposes of the dashboard (formative vs. summative) were both perceived as beneficial uses for the dashboard, although there were variable opinions on which purpose would be the most valuable for them. Some advised that they would primarily use the dashboard for promotion and tenure and merit, while others were more interested in the faculty development opportunities it could provide.

Learning Assessments

Interestingly, the 3 sub-themes for the specific dashboard requirements identified in the thematic analysis also mirror the components of a learning assessment framework that encompasses 3 types of assessments: Assessment as Learning, Assessment for Learning, and Assessment of Learning (Figure 8).[73,74] This framework includes both formative and summative assessments and helps to illustrate the various purposes for assessments of learners. These assessments, while distinctly categorized, may overlap in the education system. Nonetheless, they have been defined in order to provide more clarity on the multiple components of assessment, and to demonstrate the effects that teaching and feedback can have on learning.[73]

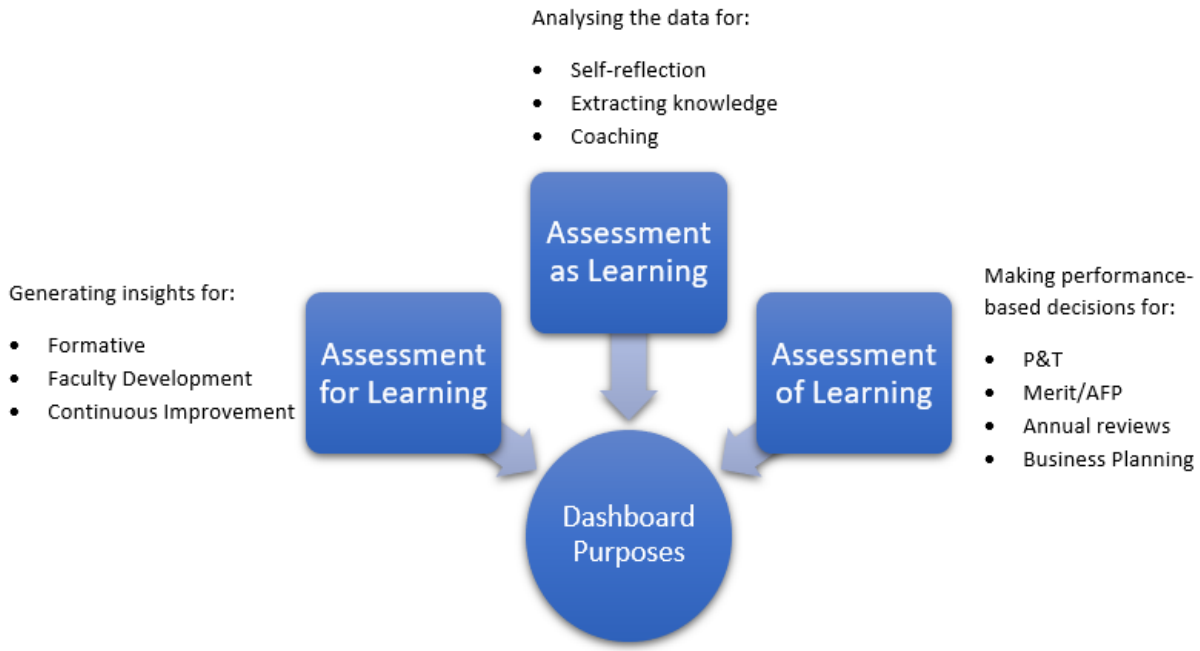


Figure 8: Three Types of Assessments in Learning for the Faculty Dashboard

First proposed by Martinez & Lipson in 1989, assessment FOR learning is a form of assessment with the primary purpose of promoting continuous, ongoing, and real-time feedback to learners so that they can further develop their knowledge, skills and improve their performance.[74] The requirement of our dashboard to 'use the data to generate insights' correlates with the purpose of this assessment method. Assessment for learning is formative in nature and is intended to include frequent, low-stakes, informal assessments that can stimulate learning. The feedback should be timely, constructive and specific in order to foster optimal learning and skill development. Assessment for learning has become recognized as an extremely important

component of the education system, often being described as more important than summative assessments.[16,73,74]

Assessment AS learning refers to the other type of formative assessment which is more centered around intrinsic discovery by the learner. This correlates with the requirement that the dashboard be used for analysis and self-reflection of the faculty member. Assessment as learning encourages the learner to become better self-aware by using the data to conduct self-examinations about themselves and their previous knowledge or experiences. It empowers the learner and encourages them to critically evaluate their performance and learning, from which they can then form judgments about their strengths, gaps and future learning needs. Similar to assessment for learning, the assessments should be low-stakes and primarily serve the purpose of promoting continuous education.[73]

Assessment OF Learning refers to the archival of achievements requirement, which encompasses assessments of what the faculty member has accomplished.[16] This category includes summative assessments which are more high-stakes compared to formative assessments. The assessment is provided after learning has taken place. Assessments of learning are geared towards those that are more formal, have a grade or score, and are used in various decision-making processes. For the dashboard, the assessment of performance and accomplishments would be a summative assessment for P&T, re-appointment and merit-based payments.[73]

Accordingly, these 3 types of assessments helped classify the various purposes of the dashboard elements and the various ways in which it could promote assessment and learning in faculty. Notably, it is now recognized that in order to foster enhanced education and lifelong development of learners, we must shift from focusing on a single form of assessment, and

instead create an assessment system. It is more effective to have an assessment system that triangulates multiple types of assessment which can then serve multiple purposes for a range of stakeholders. Thus, it is beneficial for our dashboard to support these different assessment strategies using multiple forms of assessment methods to help our faculty learn and grow.[16]

Final Prototype

Organization of Dashboard

There were three aspects of the prototype design which were particularly challenging. The first was deciding how to organize and divide up information. Dashboard pages are best kept minimalist and confined to a single page.[46,47,52] Therefore, to avoid cramming too much information onto a page that would become busy and overwhelming for the user, the information needed to be segregated into multiple pages to allow for a cleaner and more aesthetically pleasing design. The most obvious way of categorizing the pages was to sort according to the type of role (teaching, research, clinical, administration). It was not always as straightforward as this because as previously discussed, some activities blur between different roles. Consequently, it is not always entirely obvious or intuitive as to where activities and dashboard elements should be placed. Ultimately, there may be multiple ways the dashboard could be organized, and there are different lines of thought on how faculty contributions are organized.[5] In this study, I created the following pages: Teaching/education, Research/scholarship, Administration, Continuing Professional Development, and My Appointment. Some of these pages included tabs that would further break the page down into additional sections. This was felt to be intuitive and easy to navigate by end users.

Customization

Another challenge in creating the prototype was accounting for the variability in faculty roles and activities. This was an anticipated challenge, since section 2.1 has already described the complexity in scholarship across different roles, disciplines, schools, specialties and individuals. Ultimately, this means that there is no one-size-fits-all version of the dashboard. The solution to this challenge is to design a dashboard that is highly customizable. Many professional designers and dashboard experts recommend customization as one of the most important components of an effective dashboard.[46,52] There are different levels of customization that could be integrated into the dashboard:

1. Customizations across different roles (e.g. clinical educator vs. research scientist)
2. Customizations across different departments/schools (e.g. School of Nursing vs. Medicine)
3. Customization at the individual level
4. Customization for different user-groups (e.g. Chair vs. Faculty Member)

While having my prototypes evaluated, I discovered that there are countless, unique preferences between individual faculty members, even between those who work in similar roles. It would be impossible to satisfy everyone with the exact same dashboard. There will always be different needs amongst individuals, therefore the user must have the capacity to make changes to the information that is displayed on their screen. For some sections, I added a gear icon to indicate that a user could customize that section. For example, the types of teaching activities that faculty members participate in are extremely variable. To overcome this challenge, I designed this section so that the individual faculty member could click the gear icon in the top

right corner and adjust the headings and statistics that they want to appear on their dashboard (Figure 9). This functionality was well-received by participants.

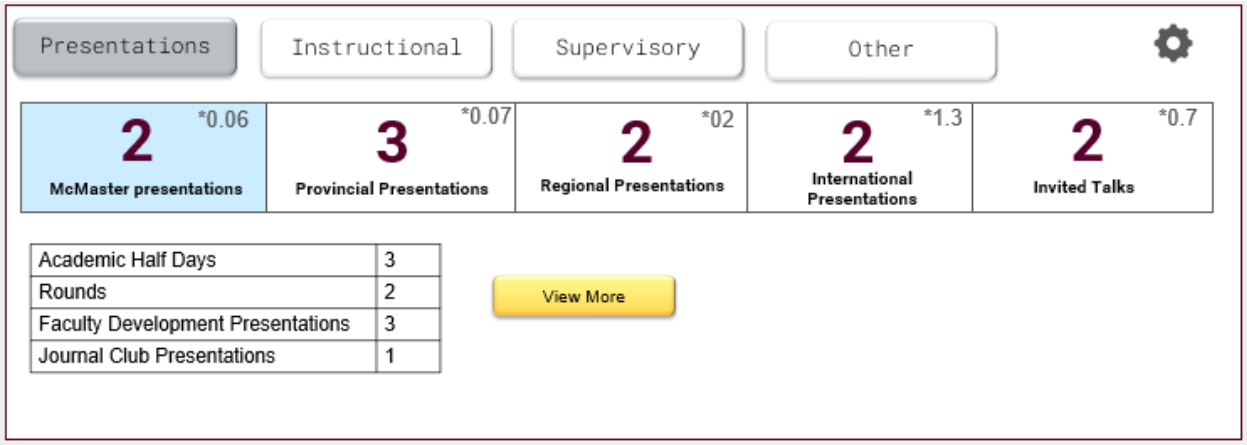


Figure 9: Customizable Teaching Activities

Scholarship Allocation

Information on the allocation of the faculty scholarship was frequently referred to as an interesting concept. Many participants stressed that they would like more information and transparency on the weighting and breakdown of how their time is spent across the domains of research, education, clinical and/or administration. In one of the first versions of the prototype, I displayed a small pie chart on the side of the home page which provided a breakdown of the faculty member's time spent working in each of the role categories (Figure 10).

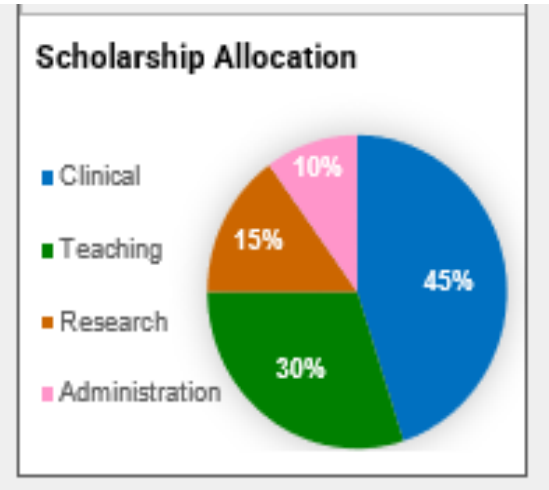


Figure 10: Faculty Scholarship Allocation Chart

As more participants expressed an interest in knowing this information, this led me to create an entirely new dashboard for scholarship and appointment information, titled 'My Appointment'. The purpose of this page was to house all relevant information surrounding the faculty appointment in regards to the R4, annual reviews and promotion and tenure. This page was well received and aligned with a lot of the summative objectives of the dashboard. On this page, I expanded on the scholarship allocation chart from Figure 10 and added an 'activity balance' section (Figure 11). This visualization compared the faculty member's R4 percentages with their actual time allocation. As described in the results, faculty members were equally intrigued and cautious of this feature. Many felt that it would be useful if the data was accurate, however they did not think this was possible. Capturing the time spent on different activities would be difficult to capture accurately.

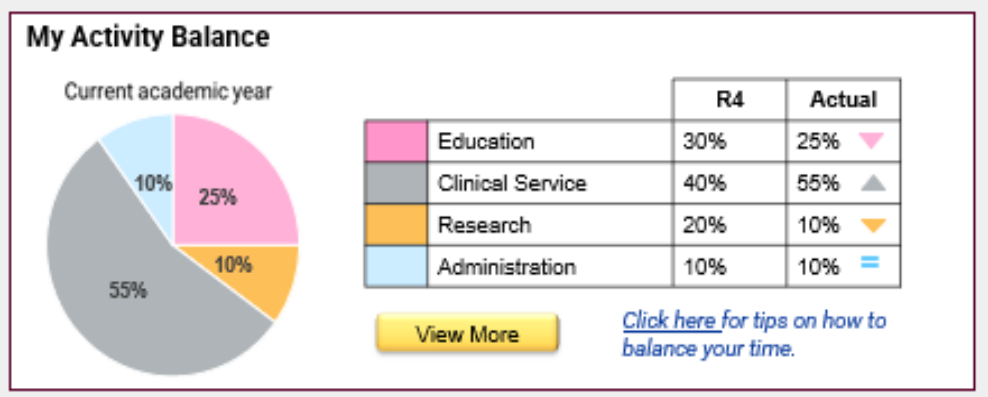


Figure 11: Faculty Activity Balance

These concerns led me to remove the 'actual' column and instead just provide a reminder of the faculty member's R4, which they could then reference and make their own estimates on whether they feel they are working within those percentages. Interestingly, one stakeholder interviewee felt that this type of candid time allocation measurement was indeed possible. This may be an area that could be explored in the future, once the University has better data capture strategies and tools.

Weighting of Data

Participants in focus groups were concerned about whether there would be a disconnect between what is displayed on the dashboard and what is valued or used for P&T or Academic Merit Funding. There is the possibility that certain elements are of interest to faculty members, but are not valued to the same degree for P&T. In fact, many participants inferred that it would be helpful if the dashboard provided a means for them to better understand how activities and achievements are used for P&T and how they translate into money for Academic Merit Funding. This study revealed the importance of making dashboard visualizations correlate with the

weighting or importance of those activities or achievements in order to provide greater transparency of summative decision-making.

Performance Parameters

Our design included features that would require defined thresholds and values to dictate how performance will be rated. For example, the management dashboard has a feature that would alert a DEC or manager if a faculty member has any flags or concerns. Whether it is professionalism issues, low teaching effectiveness scores, low productivity or lack of CPD, a defined algorithm (potentially containing Boolean scripts) would need to be built in order to perform these calculations. Decisions would need to be made as to whether these 'rules' are organizationally static or adjustable by the individual. Different managers may have different ideas of what a 'low' TES score is, or what warrants an alert. For this reason, the system should have some flexibility for users to make these types of personalized decisions.

Clinical data

An earlier prototype version contained a page of clinical performance data. Within this dashboard page were visualizations and reports of clinical interdependence statistics. This referred to the KPIs of physicians (e.g. mortality rates, number of tests ordered, number of patient seen), both with and without a medical trainee. In this way, the comparison of the data could help faculty members detect how variable their performance and behaviours were when they work alone or with a resident or medical student. Respectively, this could provide insights about the level of independence in clinician.[75] Ideally, the KPIs in the dashboard would be

personalized to the specialty of the clinician. Emergency physicians would see statistics on average time taken to the first consult. Internists may see reports on their 48-hour return and re-admission rates. Family physicians would see the number of referrals. Essentially, this page was meant to help physicians uncover new knowledge about their clinical performance and how it is impacted by trainee supervision.

Interestingly, there was a lack of interest and distrust from participants in the clinician interdependence dashboard. It was determined through reactions from participants that they were more trusting and interested in the reporting of educational, scholarly and administrative contributions on the dashboard. Due to the strong opposition of participants, the clinical interdependence page was removed from the dashboard in later prototype versions.

Notably, clinical dashboards already exist and are currently used. Solutions have already been implemented in ICUs,[49] Surgical departments,[76,77] hospital administration[78] and other settings. If a clinical page were to be added to the dashboard, intercalating the clinical data would not be a problem, given current technical ability for data from EMRs and other systems to be cross linked with the dashboard. However, more research must be done around clinical interdependence data to tease apart many of the contextual variables that will influence outcomes. As explained by faculty in this study, clinical data will vary greatly depending on a variety of factors. For example, if one physician has a higher mortality rate amongst their patients, that doesn't necessarily indicate a causal relationship or a direct correlation between negative patient outcomes and the physician's level of competence. Those who work in certain specialties may be more likely to treat a patient population with higher mortality or complication risks. Other types of specialties may be more likely to order tests, encounter patients with more complications, or perform longer consults. Therefore, work must be done to better understand

how we can interpret hard outcomes like these, while also accounting for important confounding variables. Once this has been accomplished, clinical interdependence data will provide powerful insights in the long run around the relationship between clinical and teaching performance. In conclusion, the clinical interdependence data will be a future addition to the dashboard.

Need for Interoperability/Dynamic Capabilities

A dashboard is only as good as the data that is available to feed into it. The dashboards I have created are very abundant in terms of the data it reports on. My design relies on integration with existing systems used at McMaster, so if the data does not exist or is incomplete, the dashboard will not work. Live data from multiple sources must be able to freely flow into the dashboard.[46] Unfortunately, the current state of data entry at McMaster is entirely manual. Participants made it clear that if there is too much manual data entry required by faculty or administrators to populate the dashboard, it simply won't happen. This would be far too time-consuming and onerous; it is hard to get faculty to enter their data into the current MacFACTs system. The same problem would exist if we did not incorporate automation into this tool. Automation would also make the dashboard more dynamic, which is extremely important in order to keep users engaged. Data that is old is outdated and therefore not helpful. Data that is static and does not change gives the user no reason to want to continue returning to the dashboard. Therefore, it would be best if the data was live, or at least frequently updated.

Additional Features

There were some features that were not included in the prototype design but could become future additions to the dashboard. Technology will continue to advance with new tools and techniques that become available. The faculty dashboard would benefit from leveraging these new digital innovations so that it can better serve the end users. Data scraping methods could greatly increase the value of the dashboard, as it would provide automation to the process of data gathering. Data scraping refers to the extraction of data from the outputs of a computer program or webpage. The modern employee has everything in their email, and faculty members are no exception. Email calendars are used by faculty members to schedule and keep track of their commitments. For example, a faculty member may present at rounds, but nobody else, including their administrator, would know or have evidence that this occurred. Data such as this would then either be undocumented or manually entered by the physician. Alternatively, this session could be automatically scraped from the calendar and input into the application database. A lot of faculty data also only exists in standalone documents, such as clinic schedules or CVs. Scraping could help make use of this data by allowing documents to be uploaded and then used to populate the dashboard.

Natural Language Processing (NLP) is another functionality that could provide more automation for the collection and interpretation of data. NLP is a form of Artificial Intelligence that uses rule-based modeling to allow computers to process human language and text. One of the dashboard elements (feedback quality score) already incorporated NLP as an analysis technique. NLP would be very beneficial to assess a lot of the qualitative data such as student comments. This would save the user time so that they do not have to read all of the data, but

instead be presented with a short summary or statement of their performance, which could then be translated into recommendations or predictive modeling of future performance.

Another potential innovation could involve the development of a virtual assistant. Data inputs and validation will continue to be a challenge, but virtual assistants could absorb some of this weight. Envision a faculty member forwarding a meeting calendar appointment to their virtual assistant, let's call it 'Sally'. Sally then tags this calendar appointment as a meeting and files this away so that it can then feed into the dashboard. Imagine a faculty member dictating to Sally via their smartphone that they just completed a bedside teaching session. The level of automation, organization and data capture that could result from a virtual assistant has great potential. As well as other future technological innovations, these additional features should be explored to create a more sophisticated dashboard and continue filling in the existing data management gaps.

Next Steps

Construction and Implementation of Dashboard

My thesis has demonstrated the need for a faculty dashboard and provided wireframes for the design of the tool. The next step is to move the project into the construction phase of DBR. Given the current demand for the tool by faculty members at McMaster as well as other Universities, it would be a worthwhile investment to form a solid course of action for the production of the dashboard. Since there is no solution available on the market, the dashboard would need to be constructed either internally at McMaster or outsourced to a development

company. In either scenario, the prototype designs and insights generated from this project will serve as a blueprint for the work that will follow.

If we consider building our own McMaster home-developed solution, the following SWOT analysis could provide some considerations for the University's position to develop the dashboard (Table 3).

Table 3: McMaster Faculty Dashboard SWOT Analysis

Strengths ● UCD approach to design prototypes. ● Design requirements have been gathered from multiple sources across different departments. ● There is demonstrated value and enthusiasm from end-users. ● Prototype designs have gone through multiple iterations of evaluation and revisions to ensure we are best suiting the needs of faculty members. ● McMaster is a company with access to many leaders who could provide valuable expertise to the project (e.g. Schools of Engineering, eHealth, Degroote School of Business). ● Students could assist with some of the build. ● Underserved market for faculty data enterprises means there is a high demand for this product and few competitors.	**Weaknesses** ● There is currently little to no data automation or interoperability between McMaster systems. ● There are gaps in data governance policies at McMaster pertaining to faculty and learners. ● There is currently no established budget for this project.
Opportunities ● Possibility of implementing the dashboard to other schools at McMaster or other Universities. ● Opportunity for return on investment through various positive outcomes of the dashboard (e.g. increased faculty productivity, time saved otherwise spent manually compiling information) as well as potential revenue obtained by charging users a subscription fee).	**Threats** ● Potential for emerging competitors due to pressing need for this type of solution. ● Need for funding to build team and undergo the development ● Need for staff and money to maintain the database. ● Requires the ability to pull data from other systems and enterprise solutions at McMaster, which may be difficult.

● Recognition for McMaster University's innovation and support for faculty members. ● Opportunity to improve teaching effectiveness and therefore produce positive outcomes for health education and research.	● The American Association of Medical Colleges has recently adopted a previously product for academic medical centers (Interfolio).

If we decided to move forward with the next steps of the project, I would first develop a formal business case to provide to McMaster leadership in order to acquire project approval and funding. When pitching this project, we would need to have established criteria such as estimated the project timeline, approximate budget, cost for the build and the revenue potential. An estimate of the size and composition of the project team would be required. At the very least, the team should include content experts (e.g. those knowledgeable in University policies, McMaster's enterprise systems, medical education, promotion and tenure), developers and a project manager. We would also need to plan ahead to determine who would be maintaining the dashboard and underlying database, and what these operational costs would add up to. Importantly, we would need to decide whether the product will be built for McMaster only, or whether it would be sold to other schools. This would determine how flexible and scalable the tool needs to be. Once all of these items were determined, I would build a detailed design requirements document to outline the entirety of the project plan.

This study aimed for 'blue skies' for a dashboard. In other words, we asked faculty members to dream big and envision the dashboard they would want while disregarding the practical, technical or other obstacles of building or implementing it. Even though not all elements will be immediately attainable when doing the actual build, finding out the 'gold star' for dashboard features and characteristics helped provide valuable insights on faculty member

needs. As we know, this is important because with good design comes adoptability, usability and scalability. Realistically as we prepare for the build, we would need to determine what data is doable at the time and what is the priority. Some data will simply not be possible to include at the present time because it either does not exist anywhere, or we do not yet have the capability of obtaining the data from its host system. Therefore, the most feasible solution would be to have a more simplistic, first release of the dashboard, and then continue adding more features and elements over subsequent enhancements. In doing so, it will help us implement a working dashboard sooner, with less risk of issues. Additionally, it will allow users to get accustomed to the dashboard before making it more complicated. In fact, Eckerson & Hammond 2011 articulates how:

> "The best visual displays introduce new functionality and information over time. As users become more familiar with the new environment, they typically want to view more data on a single screen and request more functions to manipulate the data. Visualization tools that expose data and functionality on demand will have higher rates of adoption among users." [42]

These types of 'on demand additions' where new features are introduced over time in stepwise fashion, have been demonstrated by companies such as IBM.[42] Therefore, the progressive enhancement strategy of the dashboard would be advantageous for the faculty dashboard. The setup of the dashboard must allow for these upgrades and changes to be made relatively easily. New elements that emerge and new data integrations means that the dashboard design will change over time, therefore it must be built with flexibility.[52]

As well as flexibility, one of the most important requirements of this dashboard is that it is scalable. To make the dashboard more customizable and scalable, I opted to create a more linear, column-based structure in the prototypes. This linear backbone could allow new data

elements to be stacked onto the existing dashboard so that the entire structure is not affected with each enhancement or customization. It may also be a good idea to allow clients the ability to swap out certain visualizations or have a 'create-your-own' page so that they can create a page that contains only the information they want to see at a glance.

Once the dashboard has been built and is ready to be put into practice, it would benefit from top-down support from leaders to entice faculty to use the system. Other change management strategies would be a valuable asset at the implementation stage, such as providing training and implementing effective communication about the dashboard and its purpose. As discovered from this study, a big selling point will be the summative use for the dashboard. While the formative uses are valuable, not every faculty member has a growth mindset and will be intrinsically motivated to use the dashboard for performance improvement. However, the results of our study suggest that many faculty members would find a lot of value in using the dashboard to assist them with their annual reporting, and for P&T. If this can be done well, it will entice a lot of faculty members to use the system. Therefore, this could be something that should be emphasized when introducing the product to new users.

Technical Considerations

Put very simply, in order to build the dashboard, we need a data warehouse on the backend that can collect and store data from multiple systems. This back-end system should also contain rules and algorithms necessary to analyze the data that is to be reported. In order for the dashboard to contain live data and be constantly updated, the back-end system must have access to the internet or intranet.[52] As identified through stakeholder interviews, the McMaster CSU

department has already begun planning to build an FHS central database. This could likely serve as part of the back-end infrastructure and source of data for the dashboard. Ideally, there could be a marriage between the construction of this dashboard and the work of the CSU office.

There are various technical considerations that will affect the success of the dashboard. The high degree of sensitivity of the dashboard and amount of personal information means that the data must be secure. The system must have good security levels and also be capable of configuring user groups to different classes. The system also must incorporate as much automation as possible. There are so many different systems and tools out there, we don't want to just add another program which would further confuse and frustrate faculty members. Likewise, we don't want to give faculty the impression that the dashboard will create a lot of additional work to upload and manage information. This automation will rely on interoperability with other systems through mechanisms such as KPIs.[52]

Once the dashboard has been constructed, it should undergo a series of usability and beta testing before the product goes live. Having end users evaluate the system will be imperative to ensure the product meets their needs. Other options for evaluating the dashboard would be considered and laid out in the project plan, such as cognitive task analysis, where the user 'thinks aloud' while using the system. Tests like these can help identify where users are having problems navigating through the system, whether they understand the information on the screen, and whether the tool is usable.[79]

Future Research

Future research should take place after the application build has been completed and implemented into practice. Adoptability, usability, and perceived level of satisfaction of users should be measured. In addition to the formative assessments that took place during the product design, summative assessments should take place after the dashboard has been built.[54] These assessments could provide insight on the efficacy of the dashboard by measuring outcomes such as changes in the quality of faculty performance, financial impacts or number of staff promoted.

The implementation of this dashboard could also be supplemented by additional work studying feedback and faculty data management culture, as well as a deeper investigation into the measurement of 'quality' performance. The challenges around how to objectively define quality performance still exist. Further, while our dashboard seeks to limit the bias and uncertainties of any single evaluation or metric by incorporating multiple data sources, some of the challenges of data reliability should also be addressed, such as the unreliability and biases of student evaluations.

More investigation could also take place around the different phenotypes of faculty members and the more specific requirements of these groups. Stage of career, role, gender and other variables that differentiate faculty needs could be further explored to better understand the differences between these groups.

Anticipated Challenges:

The nature of the proposed solution is very complex and comes with many nuanced challenges. Likely the biggest challenge will be obtaining the required technical interoperability with the other enterprise systems. This will require cooperation and collaboration with the other vendors and IT staff. If the dashboard were to be built for other universities, this will introduce even more systems and thus further compliant the technical demands. Unfortunately, some data will likely be difficult to obtain and must be manually entered. An example is any work that is done externally (e.g. presenting at another University, national committees).

When we are working with such a vast amount of data and using it to support important decisions such as P&T, we need to take extra care to ensure that the data is valid and that we trust its accuracy. As one stakeholder mentioned, it would be better to have no data than data that is outdated or incorrect. The dashboard has the potential to produce powerful reports, which could elicit outcomes that are substantially impactful for faculty members. Additionally, we need to consider the consequences of any gaps in the data collected. In order for users to trust the dashboard and feel comfortable having their information reported on it, they need to know that it will represent them fairly.

Cautions around data governance and privacy were prevalent during this study. Navigating the ethics of data gathering and reporting for the dashboard will require expert opinions. Policies will need to be developed and faculty must be aware of their privacy rights around their data. There must also be transparency around how the data will be used. If the dashboard is only to serve as a formative assessment for faculty members themselves, this is less of a concern. However, if those such as leaders are viewing the data and using it to drive

important decisions around areas such as promotions, then further discussions should take place around how this should best be communicated and handled. For example, one version of the prototype contained a section on the Chair's dashboard where they could be informed about any professionalism concerns or low evaluations on a faculty member (Figure 12). This brings to question how we can balance faculty privacy with data-driven decision making. It is likely there will be some push-back from faculty members about sharing their data with managers, prompting a need for a team of experts to be involved.

Figure 12: Low Performance Flagging

Another challenge has to do with standardization and institutional processes at the University. If this dashboard is to be used by the entire FHS group, then there needs to be standardization for items like assessment scales. For example, this study revealed that TES scales are not consistent across FHS. Some groups use a 5-point scale while others use 7-point scale. This complicates the reporting of TES scores for different learners who may have completed slightly different forms. The development of a rules engine will also benefit from some level of standardization. Rules engines refers to the back-end algorithm that would analyze and then make decisions about the data. Experts will need to be consulted to establish rules for the value of metrics that classify as high performance or low performance.[80] Further when developing these algorithms, we must ensure that we also protect against existing biases against faculty

members. The current system of faculty assessment often demonstrates sexism, racism, ageism, xenophobia and homophobia.[36,37] Therefore, the algorithms must be developed in such a way that accounts for and counterbalances these prejudices so that the system is fair and equitable for all faculty.

Strengths and Limitations

The biggest strength of this project was the scholarly approach that incorporated theory, literature, rigorous data collection, and end-user input when designing prototypes. The detailed outline of the research process and detailed documentation of design decisions will serve as a valuable guide for other researchers who wish to use a similar approach to develop a medical education dashboard. Another strength of this study was the number of focus groups and interviews we conducted. This meant that the dashboard proceeded through many iterations of evaluation and revisions. This number of sessions allowed us to reach a point where revision requests were few to none, thereby demonstrating a prototype design that was deemed to be satisfactory and met the needs of our users. We also included participants with diverse backgrounds, roles, areas of specialization and career stages. Having reached theoretical saturation in our qualitative data analysis, this strengthened our confidence in the thematic findings.

This study has limitations to be disclosed. Some criticize the grounded theory method and use of qualitative data as more abstract. By nature, this type of research is more subjective compared to other positivist approaches. However, the use of qualitative data and grounded theory analysis was deemed to be an effective approach for this study because qualitative data

allowed us to gain the rich insights from end-users which was required for the design process. Due to time constraints, the majority of the transcripts were thematically coded by one author. However, meetings and email check-ins were conducted in lieu. Regarding the literature review, this was performed informally without a standardized search strategy or screening process.

There were also limitations due to the timeline of the study and resultant scope of the project. The aim of the project was to determine the end-user needs for the dashboard, but I did not study the outcomes of the dashboard. Due to time constraints and the resources that would be needed to build the prototype, I could not investigate the outcomes of implementing the dashboard. This would be a worthwhile area to explore in future research to determine the impacts on performance, monetary statistics, faculty behaviours and other outcomes. This study used McMaster University as the study setting, which meant that some of the data elements and needs were specific to this particular school. While many of the findings are anticipated to be consistent across institutions, there are some data elements which would only apply to McMaster faculty, such as the MacExperts system which is a home-based product. However, the overall findings are transferable to other institutions and specialties (e.g. Social Sciences). While the exact prototype output may not look the same for other groups because some elements (e.g. MacExperts visualization), are exclusive to McMaster, the themes and insights around the design process will be valuable to other schools and departments. Another limitation is that the study participants were not randomly selected. While we aimed to have representation across all different user contexts (discipline, career focus, etc.), we could not guarantee that our sample was entirely representative of the faculty population. Faculty members who have an interest in medical education and technology may have been more likely to agree to participate, therefore we may have less input from faculty members who are less tech-savvy or less focused on

education and faculty development. We also did not include any adjunct or community faculty members in the data collection.

6. Conclusion

In closing, Health Sciences faculty members put forth a great deal of time and effort to contribute to healthcare, medical education and health research. Data and feedback on the performance of these faculty members should be easily accessible and presented in a way that is intuitive and can promote better data-driven decisions and insights. This DBR project gathered data from multiple sources and synergized them into a set of data requirements and recommendations for an online FHS faculty performance dashboard. Through an iterative design and end user feedback, this project produced designs of a comprehensive and multi-component dashboard that could meet the needs of researchers, teachers, administrators and clinical educators at McMaster University. Several general and specific requirements should be incorporated into the front-end design of the dashboard, which could then be tailored to multiple faculty appointments and user groups. Various technical considerations and anticipated challenges will need to be navigated when building the dashboard. However, the implemented product will produce favourable learning opportunities for faculty members. Opportunities are presented for the dashboard to leverage the McMaster central FHS database that is under development. A longer-term goal could be to market the dashboard and offer it to other Universities across Canada.

References

1. Popovich NG, Abel SR. The Need for a Broadened Definition of Faculty Scholarship and Creativity. *Am J Pharm Educ*. 2002;66(1):59-65.

2. Boyer EL. *Scholarship Reconsidered: Priorities of the Professoriate*. Princeton University Press, 3175 Princeton Pike, Lawrenceville, NJ 08648.; 1990. Accessed February 7, 2021. https://eric.ed.gov/?id=ED326149

3. Sridhar S, Dias B, Sequeira AH. *Measuring Faculty Productivity - A Conceptual Review*.; 2010. doi:10.2139/ssrn.2285279

4. Creswell JW. Concluding thoughts: Observing, promoting, evaluating, and reviewing research performance. *New Dir Institutional Res*. 1986;1986(50):87-102. doi:https://doi.org/10.1002/ir.37019865008

5. Fleming VM, Schindler N, Martin GJ, DaRosa DA. Separate and Equitable Promotion Tracks for Clinician-Educators. *JAMA*. 2005;294(9):1101. doi:10.1001/jama.294.9.1101

6. O'Brien BC, Irby DM, Durning SJ, et al. Boyer and Beyond: An Interview Study of Health Professions Education Scholarship Units in the United States and a Synthetic Framework for Scholarship at the Unit Level. *Acad Med*. 2019;94(6):893-901. doi:10.1097/ACM.0000000000002625

7. Jhala K, Kim J, Chetlen A, Nickerson JP, Lewis PJ. The Clinician-Educator Pathway in Radiology: An Analysis of Institutional Promotion Criteria. *J Am Coll Radiol*. 2017;14(12):1588-1593. doi:http://dx.doi.org/10.1016/j.jacr.2017.07.008

8. Sherbino J, Frank JR, Snell L. Defining the Key Roles and Competencies of the Clinician–Educator of the 21st Century: A National Mixed-Methods Study. *Acad Med*. 2014;89(5):783-789. doi:10.1097/ACM.0000000000000217

9. What is CBD? :: The Royal College of Physicians and Surgeons of Canada. Accessed September 21, 2021. https://www.royalcollege.ca/rcsite/cbd/what-is-cbd-e

10. Frank JR, Snell LS, Cate OT, et al. Competency-based medical education: theory to practice. *Med Teach*. 2010;32(8):638-645. doi:10.3109/0142159X.2010.501190

11. Gordon JA, Campbell CM. The role of ePortfolios in supporting continuing professional development in practice. *Med Teach*. 2013;35(4):287-294. doi:10.3109/0142159X.2013.773395

12. Middaugh M. *Understanding Faculty Productivity : Standards and Benchmarks for Colleges and Universities*. John Wiley & Sons; 2001. Accessed May 18, 2021. http://web.b.ebscohost.com.libaccess.lib.mcmaster.ca/ehost/ebookviewer/ebook/bmxlYmtfXzU2MzUzX19BTg2?sid=13c2f9e3-9d2f-4da3-b66f-954cdaf72e5b@pdc-v-sessmgr01&vid=0&format=EB&rid=1

13. Kember D, Leung DYP, Kwan KP. Does the Use of Student Feedback Questionnaires Improve the Overall Quality of Teaching? *Assess Eval High Educ*. 2002;27(5):411-425. doi:10.1080/0260293022000009294

14. Yao Y, Grady ML. How Do Faculty Make Formative Use of Student Evaluation Feedback?: A Multiple Case Study. *J Pers Eval Educ*. 2005;18(2):107-126. doi:10.1007/s11092-006-9000-9

15. Moore S, Kuol N. Students evaluating teachers: exploring the importance of faculty reaction to feedback on teaching. *Teach High Educ*. 2005;10(1):57-73. doi:10.1080/1356251052000305534

16. Norcini J, Anderson MB, Bollela V, et al. 2018 Consensus framework for good assessment. *Med Teach*. 2018;40(11):1102-1109. doi:10.1080/0142159X.2018.1500016

17. Gormally C, Evans M, Brickman P. Feedback about Teaching in Higher Ed: Neglected Opportunities to Promote Change. *CBE Life Sci Educ*. 2014;13(2):187-199. doi:10.1187/cbe.13-12-0235

18. Cashin WE. Developing an Effective Faculty Evaluation System. IDEA Paper No. 33. Published online January 1996. Accessed September 21, 2021. https://eric.ed.gov/?id=ED395536

19. Steinert Y, Mann K, Anderson B, et al. A systematic review of faculty development initiatives designed to enhance teaching effectiveness: A 10-year update: BEME Guide No. 40. *Med Teach*. 2016;38(8):769-786. doi:10.1080/0142159X.2016.1181851

20. Hattie J, Timperley H. The Power of Feedback. *Rev Educ Res*. 2007;77(1):81-112. doi:10.3102/003465430298487

21. Marsh. The Use of Students' Evaluations and an Individually Structured Intervention to Enhance University Teaching Effectiveness - Herbert W. Marsh, Lawrence Roche, 1993. Accessed May 5, 2021. https://journals.sagepub.com/doi/abs/10.3102/00028312030001217

22. Leeuw RMVD, Boerebach BCM, Lombarts KMJMH, Heineman MJ, Arah OA. Clinical teaching performance improvement of faculty in residency training: A prospective cohort study. *Med Teach*. 2016;38(5):464-470. doi:10.3109/0142159X.2015.1060302

23. Anderson DC, Harris IB, Allen S, et al. Comparing students' feedback about clinical instruction with their performances. *Acad Med J Assoc Am Med Coll*. 1991;66(1):29-34. doi:10.1097/00001888-199101000-00009

24. Skeff KM. Enhancing teaching effectiveness and vitality in the ambulatory setting. *J Gen Intern Med*. 1988;3(1):S26-S33. doi:10.1007/BF02600249

25. Bland CJ, Wersal L, VanLoy W, Jacott W. Evaluating Faculty Performance: A Systematically Designed and Assessed Approach. *Acad Med*. 2002;77(1):15-30.

26. LaDonna KA, Ginsburg S, Watling C. "Rising to the Level of Your Incompetence": What Physicians' Self-Assessment of Their Performance Reveals About the Imposter Syndrome in Medicine. *Acad Med*. 2018;93(5):763-768. doi:10.1097/ACM.0000000000002046

27. Myerholtz L, Reid A, Baker H, Rollins L, Page C. Residency Faculty Teaching Evaluation: What Do Faculty, Residents, and Program Directors Want? Family Medicine. doi:10.22454/FamMed.2019.168353

28. Harman G. Competitors of Rankings: New Directions in Quality Assurance and Accountability. In: Shin JC, Toutkoushian RK, Teichler U, eds. *University Rankings: Theoretical Basis, Methodology and Impacts on Global Higher Education*. The Changing Academy – The Changing Academic Profession in International Comparative Perspective. Springer Netherlands; 2011:35-53. doi:10.1007/978-94-007-1116-7_3

29. Longden B. Ranking Indicators and Weights. In: Shin JC, Toutkoushian RK, Teichler U, eds. *University Rankings: Theoretical Basis, Methodology and Impacts on Global Higher Education*. The Changing Academy – The Changing Academic Profession in International Comparative Perspective. Springer Netherlands; 2011:73-104. doi:10.1007/978-94-007-1116-7_5

30. Arreola RA. Issues in Developing a Faculty Evaluation System. *Am J Occup Ther*. 1999;53(1):56-63. doi:10.5014/ajot.53.1.56

31. Shin JC, Toutkoushian RK. The Past, Present, and Future of University Rankings. In: Shin JC, Toutkoushian RK, Teichler U, eds. *University Rankings: Theoretical Basis, Methodology and Impacts on Global Higher Education*. The Changing Academy – The Changing Academic Profession in International Comparative Perspective. Springer Netherlands; 2011:1-16. doi:10.1007/978-94-007-1116-7_1

32. Lewis PJ, Chertoff JD. Developing and Implementing a Web-Based Departmental Faculty Scholarly and Service Activity Database. *J Am Coll Radiol*. 2016;14(5):671-674. doi:10.1016/j.jacr.2016.10.015

33. Atasoylu AA, Wright SM, Beasley BW, et al. Promotion criteria for clinician-educators. 2003;18:6.

34. Chan TM, Kuehl DR. On Lampposts, Sneetches, and Stars: A Call to Go Beyond Bibliometrics for Determining Academic Value. *Acad Emerg Med*. 2019;26(6):688-694. doi:https://doi.org/10.1111/acem.13707

35. Hirsch JE. An index to quantify an individual's scientific research output. *Proc Natl Acad Sci*. 2005;102(46):16569-16572. doi:10.1073/pnas.0507655102

36. Heffernan T. Sexism, racism, prejudice, and bias: a literature review and synthesis of research surrounding student evaluations of courses and teaching. *Assess Eval High Educ*. Published online March 6, 2021. Accessed March 9, 2021. https://www.tandfonline.com/doi/abs/10.1080/02602938.2021.1888075

37. Boring A, Ottoboni K. Student Evaluations of Teaching (Mostly) Do Not Measure Teaching Effectiveness. *Sci Res*. Published online January 7, 2016. doi:10.14293/S2199-1006.1.SOR-EDU.AETBZC.v1

38. Beran TN, Rokosh JL. The Consequential Validity of Student Ratings: What do Instructors Really Think? *Alta J Educ Res*. 2009;55(4). Accessed February 4, 2021. https://journalhosting.ucalgary.ca/index.php/ajer/article/view/55342

39. Shevlin M, Banyard P, Davies M, Griffiths M. The Validity of Student Evaluation of Teaching in Higher Education: Love me, love my lectures? *Assess Eval High Educ*. 2000;25(4):397-405. doi:10.1080/713611436

40. Boudreaux ED, Higgins SE, Reznik-Zellen R, Wang B, Volturo G. Scholarly Productivity and Impact: Developing a Quantifiable, Norm-based Benchmarking Methodology for Academic Emergency Medicine. *Acad Emerg Med Off J Soc Acad Emerg Med*. 2019;26(6):594-604. doi:10.1111/acem.13704

41. Webber K. Measuring Faculty Productivity. In: Shin JC, Toutkoushian RK, Teichler U, editors. University Rankings [Internet]. Dordrecht: Springer Netherlands; 2011 [cited 2021 Sep 27]. p. 105–21. Available from: http://link.springer.com/10.1007/978-94-007-1116-7_6

42. Eckerson W, Hammond M. Visual Reporting and Analysis: Seeing Is Knowing. *DWI Best Pract Rep*. Published online 2011:24.

43. Hora MT, Bouwma-Gearhart J, Park HJ. Data driven decision-making in the era of accountability: Fostering faculty data cultures for learning. *Rev High Educ*. 2017;40(3):391-426. doi:10.1353/rhe.2017.0013

44. Engelbrecht L, Botha A, Alberts R. Designing the Visualization of Information. *Int J Image Graph*. 2015;15(02):1540005. doi:10.1142/S0219467815400057

45. What is Enterprise Systems | IGI Global. Accessed September 22, 2021. https://www.igi-global.com/dictionary/enterprise-systems/10003

46. Karami M, Langarizadeh M, Fatehi M. Evaluation of Effective Dashboards: Key Concepts and Criteria. *Open Med Inform J*. 2017;11(1). doi:10.2174/1874431101711010052

47. Few S. Common Pitfalls in Dashboard Design. Published online 2005:31.

48. Dashboard Design 101 :: UXmatters. Accessed June 15, 2021. https://www.uxmatters.com/mt/archives/2010/11/dashboard-design-101.php

49. Faiola AJ, Srinivas P, Doebbeling BN. A ubiquitous situation-aware data visualization dashboard to reduce ICU clinician cognitive load. In: *2015 17th International Conference on E-Health Networking, Application & Services (HealthCom)*. IEEE; 2015:439-442. doi:10.1109/HealthCom.2015.7454540

50. Yoo J, Jung KY, Kim T, et al. A Real-Time Autonomous Dashboard for the Emergency Department: 5-Year Case Study. *JMIR MHealth UHealth*. 2018;6(11):e10666. doi:10.2196/10666

51. Stone-Griffith S, Englebright JD, Cheung D, Korwek KM, Perlin JB. Data-driven process and operational improvement in the emergency department: the ED Dashboard and Reporting Application. *J Healthc Manag Am Coll Healthc Exec*. 2012;57(3):167-180; discussion 180-181.

52. Karami M, Safdari R, Rahimi A. Effective radiology dashboards: key research findings. *Radiol Manage*. 2012;35:42-45.

53. Thoma B, Bandi V, Carey R, et al. Developing a dashboard to meet Competence Committee needs: a design-based research project. *Can Med Educ J*. 2020;11(1):e16-e34. doi:10.36834/cmej.68903

54. Baxter K, Courage C, Caine K. *Understanding Your Users*. Elsevier; 2015. doi:10.1016/C2013-0-13611-2

55. Holtzblatt K, Beyer H. 2 - User Data Drives Design. In: Holtzblatt K, Beyer H, eds. *Contextual Design (Second Edition)*. Interactive Technologies. Morgan Kaufmann; 2017:31-41. doi:10.1016/B978-0-12-800894-2.00002-8

56. Garrett JJ. *The Elements of User Experience: User-Centered Design for the Web and Beyond*. Pearson Education; 2010.

57. Alben L. Defining the criteria for effective interaction design. :4.

58. Unger R, Chandler C. *A Project Guide to UX Design: For User Experience Designers in the Field or in the Making*. New Riders; 2012.

59. Lull D. UX Psychology Basics. In: Lull D, ed. *Discussions in User Experience : Healthcare for User Frustration*. Apress; 2017:11-18. doi:10.1007/978-1-4842-3267-5_4

60. Lull D. *Discussions in User Experience*. Apress; 2017. doi:10.1007/978-1-4842-3267-5

61. Venkatesh V. Determinants of Perceived Ease of Use: Integrating Control, Intrinsic Motivation, and Emotion into the Technology Acceptance Model. *Inf Syst Res*. 2000;11(4):342-365. doi:10.1287/isre.11.4.342.11872

62. McKenney S, Reeves TC. *Conducting Educational Design Research*. Routledge; 2012.

63. Baxter K, Courage C, Caine K. Chapter 2 - Before You Choose an Activity: Learning About Your Product Users. In: Baxter K, Courage C, Caine K, eds. *Understanding Your Users (Second Edition)*. Interactive Technologies. Morgan Kaufmann; 2015:22-62. doi:10.1016/B978-0-12-800232-2.00002-X

64. Baxter K, Courage C, Caine K. Chapter 1 - Introduction to User Experience. In: Baxter K, Courage C, Caine K, eds. *Understanding Your Users (Second Edition)*. Interactive Technologies. Morgan Kaufmann; 2015:2-20. doi:10.1016/B978-0-12-800232-2.00001-8

65. Outcrowd. How to Improve UX Design. Medium. Published February 16, 2021. Accessed February 16, 2021. https://medium.com/outcrowd/how-to-improve-ux-design-cd5957f98b71

66. Yablonski J. Laws of UX. Laws of UX. Accessed February 17, 2021. /

67. Brand Guidelines – Brand Standards. Accessed September 21, 2021. https://brand.mcmaster.ca/brand-guidelines/

68. Frey BB. *The Sage Encyclopedia of Educational Research, Measurement, and Evaluation*.; 2018. Accessed September 22, 2021. https://nls.ldls.org.uk/welcome.html?ark:/81055/vdc_100054368665.0x000001

69. Watling CJ, Lingard L. Grounded theory in medical education research: AMEE Guide No. 70. *Med Teach*. 2012;34(10):850-861. doi:10.3109/0142159X.2012.704439

70. Glaser BG, Strauss AL, Strutzel E. The Discovery of Grounded Theory; Strategies for Qualitative Research. *Nurs Res*. 1968;17(4):364.

71. Charmaz K. *Constructing Grounded Theory: A Practical Guide through Qualitative Analysis*. SAGE; 2006.

72. Benson T, Grieve G. *Principles of Health Interoperability: SNOMED CT, HL7 and FHIR*. Springer International Publishing; 2016. doi:10.1007/978-3-319-30370-3

73. O'Neill G, McEvoy E, Maguire T. Developing a national understanding of assessment and feedback in Irish higher education. *Ir Educ Stud*. 2020;39(4):495-510. doi:10.1080/03323315.2020.1730220

74. Martinez M, Lipson J. Assessment for Learning. *Educ Leadersh*. 1989;46(7):73-75.

75. Sebok-Syer SS, Pack R, Shepherd L, et al. Elucidating system-level interdependence in electronic health record data: What are the ramifications for trainee assessment? *Med Educ*. 2020;54(8):738-747. doi:https://doi.org/10.1111/medu.14147

76. Laurent G, Moussa MD, Cirenei C, Tavernier B, Marcilly R, Lamer A. Development, implementation and preliminary evaluation of clinical dashboards in a department of anesthesia. *J Clin Monit Comput*. Published online May 16, 2020:1-10. doi:10.1007/s10877-020-00522-x

77. Park KW, Smaltz D, McFadden D, Souba W. The Operating Room Dashboard. *J Surg Res*. 2010;164(2):294-300. doi:10.1016/j.jss.2009.09.011

78. Martinez DA, Kane EM, Jalalpour M, et al. An Electronic Dashboard to Monitor Patient Flow at the Johns Hopkins Hospital: Communication of Key Performance Indicators Using the Donabedian Model. *J Med Syst*. 2018;42(8):133. doi:10.1007/s10916-018-0988-4

79. Kushniruk AW, Patel VL, Cimino JJ. Usability testing in medical informatics: cognitive approaches to evaluation of information systems and user interfaces. *Proc AMIA Annu Fall Symp*. Published online 1997:218-222.

80. Eckerson BWW. Evaluation criteria for dashboards and scorecards -. ADTmag. Published January 1, 2005. Accessed June 10, 2021. https://adtmag.com/articles/2005/01/01/evaluation-criteria-for-dashboards-and-scorecards.aspx

81. Reeves TC, Herrington J, Oliver R. *Design Research: A Socially Responsible Approach to Instructional Technology Research in Higher Education*.; 2005.

82. Appling SE, Naumann PL, Berk RA. Using a faculty evaluation triad to achieve evidence-based teaching. *Nurs Health Care Perspect*. 2001;22(5):247-251.

83. Yin AL, Gheissari P, Lin IW, et al. Role of Technology in Self-Assessment and Feedback Among Hospitalist Physicians: Semistructured Interviews and Thematic Analysis. *J Med Internet Res*. 2020;22(11):e23299. doi:10.2196/23299

84. Collan M, Stoklasa J, Talasova J. On academic faculty evaluation systems – more than just simple benchmarking. *Int J Process Manag Benchmarking*. 2014;4(4):437-455. doi:10.1504/IJPMB.2014.065522

85. Arreola RA, Aleamoni LM. Practical decisions in developing and operating a faculty evaluation system. *New Dir Teach Learn*. 1990;1990(43):37-55. doi:https://doi.org/10.1002/tl.37219904305

Appendix A

Competitive Analysis

	UNIweb (Proximify)	**SEDONA**	**Interfolio** (Faculty180)	**Digital Measures/ Watermark**
Program Website	https://uniweb.io/en/index.html	https://sedonaweb.ca/i/index.cfm	https://www.interfolio.com	https://www.watermarkinsights.com/
Year Launched	2012	~2000	1999, some features only launched in 2020	2018
Company Country	Canada	United States	United States	United States
Design Strengths	• Some integrations with big companies (Google scholar, Orcid)	• Ability to generate reports on demand and download all data • ePortfolio that is designed to be used for P&T. • Produces annual merit reviews • Tracks grants, awards, research activities	• Data validation- faculty prompted to validate their data before it is saved to their profile • Can lookup colleagues to collaborate with • Data processing (e.g. consolidate duplicate records)	• Can pull information from uploaded CV • May be able to pull data in from other sources, but appears to require a lot of manual entry
Design Weaknesses	• Research-focused	• Likely requires a lot of manual data entry • More general in focus (less on clinicians and FHS)	• More general in focus (less on clinicians and FHS)	• More general in focus (less on clinicians and FHS)

Customer Base	University faculty members and researchers	University faculty members, administrators, P&T committees/reviewers	Higher education members and administrators	Higher education faculty members and administrators
Core Features	• Create reports and CVs • Cloud-based data storage • Public online webpages to connect with others	• Enter data on faculty member teaching, research, service, etc. • Generate customizable reports • Query database • Track member activities, awards, committees, etc. • Evaluation and form builder • P&T reports • Score cards • Query/format CVs • Enter and manage course schedules	• Maintain and generate CVs • Link activity data to website scholar profiles • Generate faculty activity reports for accreditation, etc. • Pulls data from faculty member's work into database	• Data entry of accomplishments, etc. • Reporting and customizable workflows • Central database • Create custom CVs and accreditation reports
Examples of Universities that Use this	McGill, uOttawa, Queens, Dalhousie, University of Lethbridge	University of Tennessee, Duquesne University, University of Houston, University of Guelph	University of Virginia. University of Chicago, Brown University	Marquette University, University of Maryland, Sam Houston State University

	Mentis	**Lyterati (Entigence)**	**One45**
Program Website	https://www.inknowledge.com/#mentis	http://lyterati.com/	https://one45.com/
Year Launched	2013	Unclear	2001

Company Country	United States	United States	Canada
Design Strengths	• Networking and social aspect • Reports and analytics • Cloud-based	• Supports P&T processes • Company claims they can integrate data from other University databases	• Data warehouse that integrates data from other systems • Pulls spreadsheets or local databases into warehouse • Extract-Transform-Load (ETL) every 24 hours • Customizable data flow
Design Weaknesses	• Primarily research focused	• A lot of manual entry • May not meet specific needs of clinical educators	• Data are on students and programs, not faculty members • Only applicable to medical education, not other FHS disciplines
Customer Base	Researchers, Chairs and Deans	Faculty, Chairs, Deans	Medical Education programs, clinical trainees
Core Features	• Run reports • Maintain CVs • Automatically update websites • Find other researchers to collaborate with • Track grants and awards	• Data entry • Creates reports (annual reports, P&T, etc.) • Faculty and admin dashboards • Load data directly from CV • CV maker	• Scheduling and management of clinical placement and teaching sessions • Clerkship lottery • Curriculum Mapping • Track learner grades • Assessments • Dashboards and reports of learner and program performance

Examples of Universities that Use this	Unclear	George Washington University	University of Ottawa

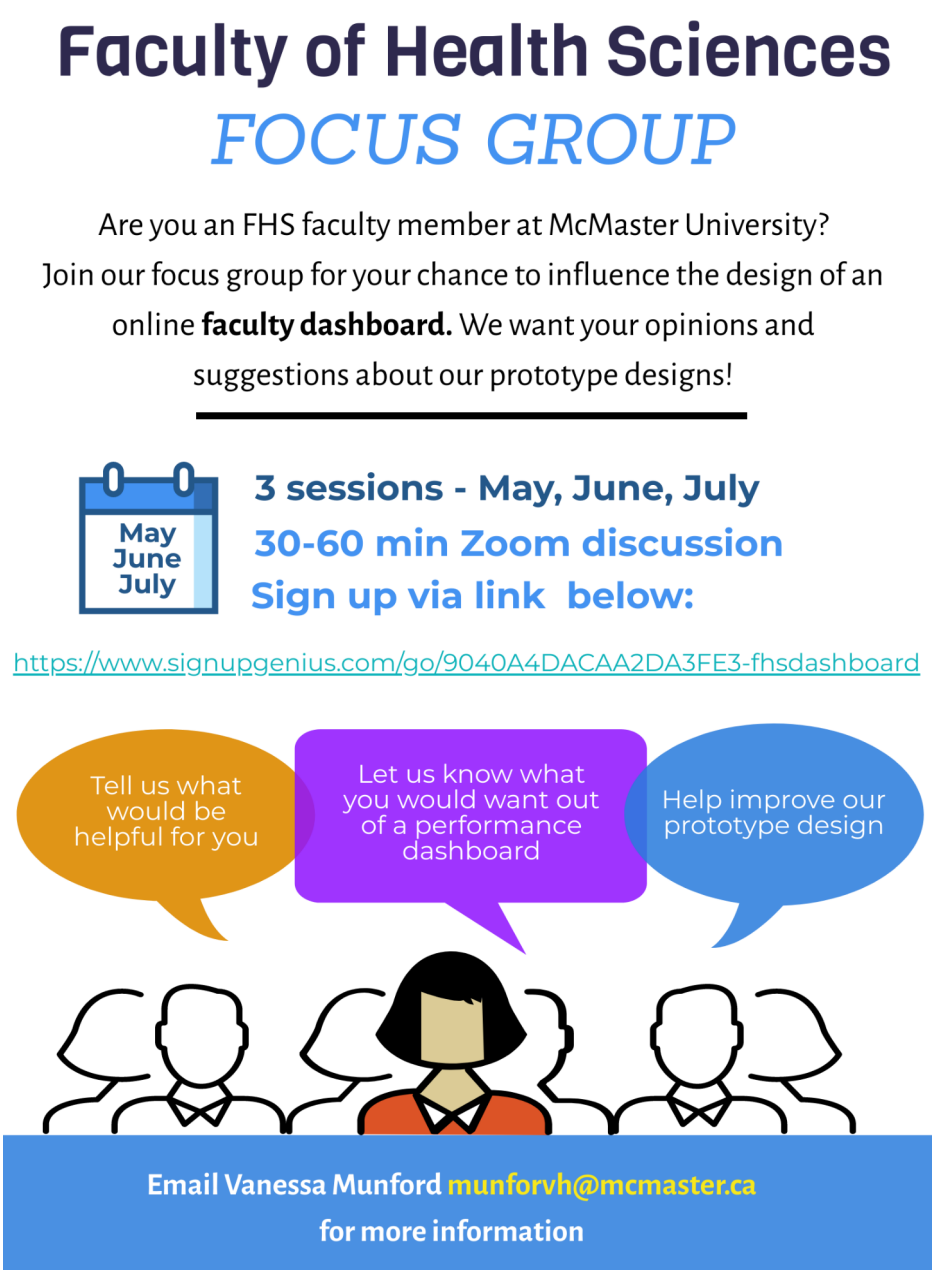
Appendix B

Stakeholder Groups

Stakeholder group	**How they will be impacted**
Faculty Members	Primary end-user: Their data will be used to populate the dashboard.
Department Managers	Global statistics can provide insight into department productivity and performance.
Department Chairs	Use the dashboard for annual review meetings with faculty members.
DECs	Use the dashboard to review performance and help faculty members with promotion.
Finance/administration offices	Use global stats to allocate funds. Individual faculty data for merit-based pay and annual reports (e.g. AFP).
Program Administrators and Secretaries	Potentially responsible for some of the data entry and validation.
Promotion and Tenure Committee Members	Use the dashboard for reviewing faculty members for P&T.

Appendix C

Focus Group Infographic



Appendix D

Annotated Bibliography

Source of Resource	Topic	Comments
Thoma et al. 2002 [53]	Methods	Example of DBR study to build an online dashboard for competence committees. The framework of this study was used as a model for this project.
Reeves et al. 2005 [81]	Methods	Resource for educational design-based research (EDR) projects. Provides definition and reasoning for design research. discusses the phases and hallmarks of EDR.
McKenney & Reeves, 2012 [62]	Methods	Resource for educational design research (EDR). Discusses the phases of an EDR project and provides useful recommendations for EDR projects.
Appling et al., 2001 [82]	Feedback; Faculty Data Systems	Authors developed an instrument for faculty evaluation data. Outlines trio of faculty evaluation data sources - student ratings, teaching portfolio and peer evaluations. Provides examples of the data that should be included in our dashboard and emphasizes the importance of compiling data from multiple sources.
Yin et al., 2020 [83]	Methods; Feedback; Faculty Data Systems	Example of study following similar design-based methods as my project. Outlines some data elements that could be useful for clinician faculty members. Authors conducted qualitative interviews with physicians and designed wireframes of a performance feedback application. Results showed that participants felt that there was value to having all information compiled into a single interface (supports the need for our faculty performance dashboard).
Collan et al., 2014 [84]	Faculty Data Systems	Case studies of evaluation systems at other universities. Discusses the pros and cons of each, the challenges and gaps, etc. Helps provide some examples of the evaluation data that is reported in other University systems in other countries, how the data is collected, how it is reported, etc. Background info on need for faculty evaluation systems (P&T, faculty development, etc.). Emphasizes that faculty evaluations are complex.
Lewis & Chertoff, 2016 [32]	Methods; Faculty Data Systems	Authors built a system for radiologists to collect data for feedback and P&T. Similar to the tool being designed in this study. that we will be building for FHS.
Baxter et al., 2015 [54]	User-Centred Design	Book with recommendations on how to build a user-centred design - stakeholder interviews, UX, focus groups, competitive analysis, requirement gathering, etc.
Lull 2017 [60]	User Experience	Book about User Experience - Contains useful definitions, design principles, UX tips (e.g. flow, eye movement, etc.). Helpful concepts to keep in mind when designing my prototypes (e.g. preventing cognitive overload).

Arreola & Aleamoni, 1990 [85]	Faculty Data Systems	Highly cited paper that discusses the requirements for a faculty evaluation system. Outlines the purpose of these systems (formative and summative), data storage/confidentiality considerations, how data should be reported/interpreted, etc.
Bland et al., 2002 [25]	Faculty Data Systems	Paper about developing an online faculty evaluation system (Merit Review System - MRS) for a Family Medicine Department. Provides background information about why an evaluation system is required for feedback. Includes lessons learned and future directions.
Boyer 1990 [2]	Faculty Scholarship	Paper that paved the way for the recognition of the complexity of faculty scholarship and the scope of practice. Discusses the increasing complexity of faculty roles, ROAs, and how performance should be documented and assessed. Faculty scholarship was traditionally viewed as just including research and instructional teaching. Boyer explains how faculty scholarship includes a much more diverse range of activities which vary across disciplines. This justifies our need to gather requirements so that we can ensure our dashboard meets the needs of a range of faculty with multiple roles and data sources.
Sridhar et al., 2010 [3]	Faculty Scholarship; Feedback; Performance Metrics	Discusses the measures for faculty productivity and how to quantify faculty output. Discusses the different measures and evaluations of performance (teaching, research, faculty productivity as a whole). Different models used to measure productivity are mentioned that have been cited in the literature (may want to consider using some in the dashboard). Discusses how to assign weights to different components. Supports the notion that faculty need multiple, variable data to accurately portray their teaching effectiveness. "Since, measuring TE [teaching effectiveness] is not necessarily an exact science; the more varied the data sources, more accurate the measurement is likely to be."
Myerholtz et al., 2019 [27]	Feedback	Study where authors interviewed Program Directors and faculty members from a residency program to find out what feedback they want. Provides evidence that faculty desire more real-time, easily accessible evaluation data.
Hora et al., 2017 [43]	Feedback; Faculty Data Systems	Paper about data driven decision-making (DDDM) for faculty members in higher education. Discusses lessons learned from K-12 and the challenges with faculty data in higher education. Study explores the use of DDDM at several science and engineering faculties at different universities. Emphasizes the reliance on data expertise to analyze and interpret faculty data, which shows the importance of having the data laid out for faculty in a way that is understandable and actionable.
Cashin 1996[18]	Feedback; Faculty Data Systems	Discusses recommendations for a faculty feedback system. Outlines the summative and formative uses for faculty data and the recommendations from the literature regarding what makes a successful faculty evaluation system (e.g. flexibility).

Boudreaux et al., 2019 [40]	Faculty Scholarship; Performance Metrics	Authors developed approach to use data to assess scholarly productivity and impact of EM physician faculty members. Provides good examples of the data that would be useful to display in the dashboard (e.g. h-index as opposed to just # publications).
Steinert et al., 2016 [19]	Feedback	Systematic review of faculty development initiatives in the literature. Provides good support for the need for feedback in faculty development and skill development.
Atasoylu et al., 2003 [33]	P&T	Paper that surveyed Department Chairs and P&T committee chairs to find out how they measure performance of clinical educators. Outlines some of the areas that are highly valued and should therefore be featured in the dashboard (e.g. teaching awards).
Watling & Lingard, 2012 [69]	Methods	Paper that describes and provides instructions for grounded theory approach in medical education research.
Fleming et al., 2006 [5]	P&T; Faculty Scholarship; Performance Metrics	Commentary about the current gaps surrounding the promotion and tenure process for clinical educators. Demonstrates that the scholarship of clinical educators is unique compared to other disciplines, particularly due to the patient care demands. Provides an example of how clinical educator scholarship should be categorized for documentation systems.
Engelbrecht et al., 2015 [44]	Data Visualisation	Provides design principles and guidelines for the design of visualisation tools. Describes the meaning of information and knowledge visualisation and provides recommendations when designing these types of solutions.
Karmai et al., 2012 [52]	Dashboards and Design	Study to assess the criteria that contribute to an effective healthcare dashboard. This paper outlines a list of recommended features and characteristics of the dashboard which should be incorporated into the selection, design or building of a dashboard. The recommendations were helpful to inform the design of the dashboard for this study.
Karami et al., 2017 [46]	Dashboards and Design	Discusses the recommendations for designing a dashboard for a radiology department. The recommendations described by the authors was transferable to my project dashboard, including the design and architectural requirements.
Few, 2005 [47]	Dashboards and Design	Outlines the do's and don'ts of designing a dashboard. Beneficial design principles that were used to build the dashboard for this project.

Appendix E

Stakeholder Interviewees

Stakeholder Name	Role	Gender	FHS Department	Role
Sara Sellers	Administrator	Female	Medicine	Assisting Medicine Faculty Members with appointment and preparing for P&T
Tracy Mestdagh	IT Director	Male	FHS CSU	Leading a project to build a new FHS database system
Andrew Folino	Financial Coordinator	Male	Medicine	Financial Coordinator
Graeme Matheson	Finance Manager	Male	Medicine	Finance Manager
Cathy Stampfli	Administrator	Female	Family Medicine	Assisting with the P&T administration processes
Sharon Hendershott	Administrator	Female	Medicine	Assisting with the P&T administration processes
Pamela Elmhirst	Department Manager	Female	Surgery	Managing a department, hiring faculty members, overseeing department operations
Dr. Feng Xie	Faculty Member	Male	Medicine	Faculty member who has been interested in developing a similar tool.
Kevin Kennedy	Student	Male	Health Research Methods, Evidence & Impact	Student with software development background who has been considering building another type of faculty application
Dr. Ranil Sonnadara	Faculty Member/Committee member of McMaster IT Advisory Board	Male	Surgery	Responsible for digital research and digital infrastructure at McMaster University. This stakeholder is also a faculty member who could use the tool themselves.

Appendix F

Sample Medicine AFP form values

Section	**Mean Value**	**SD**	**Min**	**Max**
MD Undergrad Medical (hours)	91.88	101.77	0	302
Clinical Supervision (hours)	279.88	202.28	108	600.5
Academic Administration (hours)	188.18	139.27	0	448
Academic Curriculum (hours)	72.25	54.77	0	178
Graduate (hours)	34.00	76.71	0	218
Undergraduate (hours)	0.00	0.00	0	0
Physician Assistant Program (hours)	0.94	2.65	0	7.5
Totals				
Total Education (hours)	940.21	593.18	361.5	2292.5
Total Research (points)	273.94	421.44	25	1238
Total Alternative Curriculum Delivery (hours)	3.38	5.68	0	16
Total Guideline Development (hours)	0.00	0.00	0	0
Total QIPS (points)	29.25	82.73	0	234

**QIPS = Quality Improvement and Patient Safety Contributions*

Sample Medicine AFP form variables

Document Variables	**Total**
Rank	
Clinical Scholar	1
Assistant Professor	3
Associate Professor	3
Professor	2
Self-Assessment - Overall Educational Assessment	
Exceeds Expectations	4
Meets Expectations	5
Self-Assessment - Overall Research Assessment	
Exceeds Expectations	3
Meets Expectations	6

Appendix G

McMaster Policies Reviewed

Policy Title	**Policy Number**	**Importance**
McMaster Tenure And Promotion Policy	N/A	Policy for full-time McMaster faculty to outline the policies, criteria, timing and procedures for academic appointment, tenure, permanence and promotion. This provided context around how the dashboard could fit within these policies.
Preparation of Dossiers for ReAppointment, Tenure/Permanence and/or Promotion	SPS B12	Outlines the necessary components of a teaching dossier required when going up for reappointment, promotion or permanence (e.g. need three references from peers). These mandatory components are potential data elements to be included in the dashboard.
Teaching Portfolios	SPS B2	Describes the purpose of teaching portfolios and outlines a proposed structure. Provided ideas for how the dashboard could be designed in a similar manner.
Procedures for the Assessment of Teaching	SPS B1	Describes the importance of the assessment of teaching and how it is used for reappointment, tenure, promotion or permanence at McMaster. This provided context for the types of assessments that should be included in the dashboard (e.g. student feedback questionnaires).
Clinical Activities Portfolio – Clinician Educators, Faculty of Health Sciences	SPS B3	Outlines the required components of a clinical activity portfolio to be used when going up for reviews, promotion or reappointment. Lists many examples of activities that faculty members should track (e.g. development of teaching materials, grand rounds presentations, etc.).
Policy for Referees – Teaching-Stream Faculty	SPS B8	Outlines the requirements for faculty members to be promoted in the teaching-stream.
Policy for Referees – Tenure-Stream Faculty	SPS B7	Outlines the requirements for faculty members to be promoted in the tenure-track.
Policy for Referees – Clinician Educator Faculty	SPS B9	Outlines the requirements for clinician educators to be promoted.
Guidelines for Balancing Teaching, Research and Service		Describes the faculty member's obligation to balance their time across teaching, research/scholarship and University service, the specific weighting of which will vary by faculty member. The allocation of scholarship was a frequently discussed topic in focus groups.

Faculty of Health Sciences/Affiliated Teaching Hospital Appointment & Annual Review: Details of Mutually Agreed Responsibilities (R4)	N/A	Provides context on the R4 and who completes and reviews the R4. This provided background information about the R4, which was a commonly requested element in the dashboard.

Appendix H

Use Cases

Use Case Name: Professional Development	
Primary Actor: Faculty Member	
Short Description:	This use case describes how a faculty member would view their dashboard for professional development, career growth, and to enhance their performance. The faculty member will log into the system at regular intervals throughout the year to check whether they are performing adequately, or if there are areas that require improvement. They will view the high-level statistics on the main dashboard pages, and then click on the various components to drill down into areas that are of particular interest to them or suggest an area of weakness. They can then reflect on the information in the dashboard and plan to make changes to their teaching or performance in response to this feedback.

Use Case Name: Preparing for annual review	
Primary Actor: Faculty Member	
Short Description:	A faculty member may wish to prepare for their annual review with the division chair and plan ahead for the upcoming year. This faculty member wants to see whether they are allocating the appropriate amount of time and effort towards research and education so that they can decide if they want to re-negotiate their R4 with their Chair. They may want to know if they have met the requirements to move to a full-time track so that they can discuss this possibility. They want to see what was discussed at the last annual review meeting so that they can feel better prepared for discussion at the next meeting.

Use Case Name: Promotion and Tenure	
Primary Actor: DEC/ Department Chair	
Short Description:	This use case describes how a reviewer would view the dashboard reports of a faculty member while assessing their eligibility for promotion. This actor would analyze the dashboards to provide supporting evidence for the faculty member's performance and amount of service, which would help them make more objective decisions on whether they are ready for a promotion.

Use Case Name: Assessing Faculty Productivity and Performance Trends	
Primary Actor: DEC, Divisional Director, Department Chair, Manager	
Short Description:	This use case describes how a lead, such as a DEC, would view the performance of faculty members within their department or division, to gain a sense of the overall performance as a whole, as well as pinpoint any faculty members who are underperforming (may need supports) or over performing (should be recognized, such as through award nomination). The actor would look at the high-level department statistics to gauge whether the faculty group is inclusive (EDI, gender, etc.). The actor may then look at the overall TES scores and look in more detail at any faculty members who have lower than average scores. They could then plan to monitor or meet with this faculty member to provide coaching or recommendations.

Appendix I

Personas

Persona - Dr. Lisa Terry

"I think there is an accountability amongst physicians for continuous growth and improvement"

Age: 40
Gender: Female
Position: Assistant Professor
Primary role: Clinical Educator- Hematologist
Secondary role:
Track: Full-time

Personality

- Analytical, likes numbers and stats
- Growth mindset
- Career-oriented
- Ambitious

Bio

Dr. Terry is a clinician who practices in Hematology. She is an ambitious junior faculty member who enjoys clinical education and teaching. She is an active member of the Hematology residency and clerkship programs and hopes to become the Program Director in the near future. Dr. Terry has a diverse scholarship and would like to be able to know whether she is on track for a promotion and how productive she is compared to the average clinician educator. She would like to have a better idea of how she can improve her clinical teaching.

Wants/Needs

- Improve her own clinical and teaching performance
- Receive more feedback and have it analyzed for her in a way that makes sense
- Get a sense of where she stands when compared to peers
- See what milestones or activities are required for her to be promoted to full professor

Technology

Computer literacy

Trust in technology

Social Networks

Pain Points

- Contributes a lot of time and effort through various scholarly activities and educational initiatives but doesn't have a place to view information on all of these contributions.
- Doesn't find the current sources of feedback useful for her to improve
- Doesn't know when she will be ready for promotion or what is required.

Motivations

Improve Performance

Promotion and Tenure

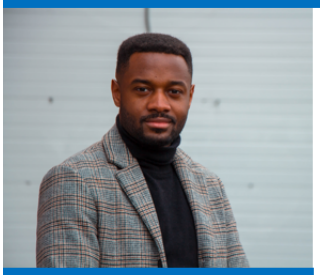
Track Scholarship and Productivity

Identify mentors

Compare to colleagues

Reduce data entry and gathering

Persona - Dr. John Davis



"Sometimes I don't feel like management understand what I do. Comparing my outputs to colleagues would be like comparing apples to oranges".

Age: 38
Gender: Male
Position: Associate Professor
Primary role: Course Instructor
Secondary role: Researcher
Track: Full-time

Personality

- Creative
- Forward-thinking
- Outgoing
- Interested in technology

Bio

Dr. Davis is an instructor in the Health Sciences at McMaster University. He teaches a range of students including undergraduate, medical students and residents. Dr. Davis's appointment and scholarship is more unique than the traditional faculty member. Many of his activities do not fall within the traditionally defined activities. For example, rather than produce traditional research outputs through journal articles, Dr. Davis disseminates knowledge through blog posts, podcasts and social media. Dr. Davis would like to be able to highlight his contributions for his Chair when he has annual reviews.

Wants/Needs

- Improve her own clinical and teaching performance
- Receive more feedback and have it analyzed for her in a way that makes sense
- Know how she compares with other colleagues in similar roles
- See what milestones or activities are required for her to be promoted to full professor
- Have a way to showcase her accomplishments

Technology

Computer literacy

Trust in technology

Social Networks

Pain Points

- Does not feel that his scholarship fits within the typical faculty phenotype
- Does not feel that his non-traditional activities are recognized or valued by the University
- Has no way of organizing his activities in such a way that can effectively display the entirety of his work.
- Does not want to be unfairly compared to colleagues due to the uniqueness of his role.

Motivations

Improve Performance

Promotion and Tenure

Track Scholarship and Productivity

Identify mentors

Compare to colleagues

Reduce data entry and gathering

Persona - Dr. Julie Yang

"I would highly value the opportunity to find a coach or a mentor who could help me find my own path".

Age: 42
Gender: Female
Position: Associate Professor
Primary role: Researcher
Secondary role: Teacher/supervisor
Track: Full-time

Personality

- Thoughtful
- Sometimes resistant to change
- Passionate about research
- Has a family and likes to maintain a healthy work-life balance

Bio

Dr. Yang is a research scientist who has been working in the McMaster Health Sciences Department for several years. She supervises many students on research and thesis projects. Dr. Yang would like to begin taking on more leadership opportunities, and would like to have a coach help her with this transition.

Pain Points

- Does not feel supported or connected to colleagues
- Does not want to have to enter and track her activities.
- She is somewhat unreceptive to new technology and often feels that new systems just introduce more work and confusion.

Wants/Needs

- Obtain a mentor
- Take on new roles and leadership positions
- Reduce the amount of data entry and reporting she is required to do
- Connect with other researchers

Technology

Computer literacy

Trust in technology

Social Networks

Motivations

Improve Performance

Promotion and Tenure

Track Scholarship and Productivity

Identify mentors

Compare to colleagues

Reduce data entry and gathering

Persona - Dr. Lori Goodwin

"At my stage of career, it would be most useful for me to have a tool that can help me assess and coach other faculty."

Age: 56
Gender: Female
Position: Professor
Primary role: Dean of Nursing
Secondary role:
Track: Full-time

Personality

- Analytical, likes numbers and stats
- Growth mindset
- Career-oriented
- Ambitious

Bio

Dr. Goodwin is the Dean of Nursing and oversees all the faculty in the School of Nursing. Dr. Goodwin is at an advanced stage in her career, therefore she is less focused on her own development and more interested in helping other faculty members grow and succeed.

Pain Points

- A lot of her work relies on others to gather the data (faculty members to compile their own portfolios, secretaries to gather departmental statistics). This often means it is not comprehensive or timely.
- Does not feel the current systems at McMaster are effective at producing reports that are meaningful for her.

Wants/Needs

- Have better documentation of faculty achievements for conducting annual reviews
- Get more insights about her department so that she can plan future directions
- Get data on the diversity of her faculty for accreditation purposes (e.g. EDI, age range, gender)

Technology

Computer literacy

Trust in technology

Social Networks

Motivations

Improve Performance

Promotion and Tenure

Track Scholarship and Productivity

Identify mentors

Compare to colleagues

Reduce data entry and gathering

Appendix J

Possible Dashboard Elements

Faculty Need	Dashboard Element	Feedback Study	Stakeholder Interview	Document Analysis	Literature Review	Focus Group/Interviews
Support Annual Reviews	Date of meetings (upcoming and previous)					X
	Previous document attachments and report from Chair					X
	Tips on how to prepare for next meeting					X
Support P&T	Deadlines and Upcoming Dates					X
	Required milestones to next step	X				X
	Peer Observations/Reviews	X		X		X
	Progress towards next stage					X
	Recommendation for promotion					X
	Links to resources and tips					X
Alerts and Notifications	Upcoming teaching activities					X
	Previous milestones/events/achievements (memories)					X
	Upcoming meetings and events					X
	Deadlines (e.g. CPSO renewal, paper submission due)		X			X
Clinical Interdependence Stats	Order numbers (e.g. CTs) with/without learner					X
	How fast I see patients with/without learner					X
	How many patients with/without learner					X
Research Activity	Publication Analytics (similar to Google Analytics or Research Gate):	X				
	Number/list of publications	X		X	X	X

	Number/list of citations	X		X	X	X
	Different projects involved in					X
	Research students supervised					X
	Review to publication ratio					X
	Non-traditional research activities	X				
	Top journals published in	X				X
	Quality of journals published in				X	
	# Conference presentations	X				
	Number times paper resubmitted before accepted	X				
	Projects started vs. finished					X
	Local vs. global impact	X				
	Orchid ID		X			
	Number peer reviews completed					X
	Editorial board positions					X
	Research consults completed					X
	Altmetrics					X
	Other forms of knowledge translation (e.g. media broadcasts)				X	X
	h-index				X	X
Knowledge Translation	Local vs. International					X
	Invited talks					X
	Workshops					X
Grants	Number grants received				X	
	Number grants submitted					
	How much money left in each account					X
Social Media	Recent social media activity				X	X

	Share data to social media					X
	K-index				X	X
Awards/achievements	Awards received				X	
	Awards Nominated for				X	X
	Awards students/mentees won					X
Mentorship/coaches	Notification that you are eligible to be a mentor	X				
	Identification of mentors/coaches for you	X				X
Comparative Analytics	Compare to mean of other faculty members (division, department, level of tenure)	X		X		X
	Show highest scoring colleague (anonymized)	X				
	Compare to myself in previous years	X				X
	Comparing career trajectories	X				
Professional Development	Micro-credentials					X
	Completed activities					X
	Upcoming activities					X
Narratives	Research mission/philosophy					X
	Candidate/personal statement		X			X
	Teaching Mission/philosophy				X	X
Self-assessment	Overall Educational Self-Assessment (Below expectations, meets expectations, exceeds expectations)	X		X		
	Overall Research Self-Assessment			X		
Teaching Activities	Presentations			X		X
	Supervisory Roles			X		X
	Clinical supervision			X	X	X
	Student supervision/mentorship			X	X	X

	Other non-traditional teaching activities (e.g. curriculum development)			X		X
	Breakdown of learner level and program					
	Courses		X		X	X
	Sessions facilitated (e.g. Tutorial)		X	X		X
Evaluations	TES reports	X				X
	Presenter evaluations	X				
	Assessments by CanMEDS roles	X				
	Teaching evaluations broken down into sub-components	X				X
	Highlighted anomalies	X				
	Rotation Evaluations	X				X
	Peer evaluations of teaching					X
	360 evaluations	X				X
	Assessments from simulation sessions	X				
	Completion rates					X
Feedback on feedback	# Assessments (e.g. EPAs) completed vs. incomplete	X				X
	NLP for feedback quality (student to faculty)					X
	NLP for feedback quality (faculty to student)					X
	Coaching on how to improve on providing feedback					X
Patient feedback	Patient feedback- letters	X				
	Dictations	X				
Social Features	Ability for coach/chair to add comments					X
	Community of practice		X			X
	Messaging centre					X

Website analytics	Performance of website (e.g. for teaching), # visitors	X				
	Length of time spent on page	X				
Data for Academic Merit Funding and AFP	Clinical supervision			X		
	Academic administration			X		
	Academic curriculum			X		
	Graduate			X		
	Undergraduate			X		
	PA Program			X		
	Total Education Hours			X		
	Total Research Points			X		
	Total Alternative Curriculum Delivery			X		
	Total Guideline Development			X		
	Total QIPS			X		
	Weighting of activities			X		X
	Information about Merit					X
Other features	Algorithm to adjust for inequalities (e.g. female vs. male)	X				
Recommendations	Highlight areas of improvement	X				X
	Learning Plan	X				
	Additional reading materials and resources					X
	Next step in leadership					X
	Recommended activities, courses, events					X
Reporting	Generate teaching dossier template					X
	Exportable tables					X
CV Builder	Generate CV			X		X
	Sub-categories of types of CVs					X

Administration/Leadership	Committees				X	X
	On-campus roles				X	X
	External roles					X
	Community Service Work (e.g. media interviews)					X
Department statistics	Faculty by PT vs. FT					X
	Gender statistics		X			X
	Age ranges					X
	EDI		X			X
	Degrees					X
Notifications for DECs/Chairs	Professionalism concerns					X
Scholarship/ weighting	Allocation of roles (research, teaching, etc.)					X
	Intensity of activities					X
	Hours a day spent working					X
	Tracking impact- how much time spent to get level of productivity					X
Goals	Personal goals with proportion achieved					X
	Team or leadership goals					X
Merit	Information about Merit					X
	Weighting of activities for Merit			X		X
Wellness	Wellness/burnout score					X
	Self-reflections					X
	Wellness resources					X
Titles	Research titles					X
	Teaching titles					X

	Administrative titles					X
Network	MacExperts		X			X
	Top collaborators					X
	Trainee network (mentorship lineage)					X
	Where my students are now					X
Overall features	Date filter				X	X
	Navigation tabs				X	X
	Other filters (e.g. type of learner)	X				X
	Different user access				X	X
Data input	Option for manual data entry		X	X	X	X
	Option to upload documents		X			X

Appendix K

Specific Front-End Requirements

Reporting for Insights	Data for reflection and analysis	Archival of achievement

- Projects I'm involved in
- Accurate representation of performance/progress
- Types of learners
- Feedback on impact
  o Student achievements
- Teaching/Education activities
  o Recent activities
  o Upcoming activities
  o Different types of teaching activities
  o Clinical supervision
  ▪ Models of clinical supervision
  ▪ Clinical interdependence
- Feedback quality score
  o Staff to learner
  o Learner to staff
- Peer evaluations of teaching
- Administration/leadership
  o Breakdown by intensity
  o Different types of administrative activities
- Network
  o MacExperts
  o Social Media Activity
  o Community of practice
  o Social interactions
- Professional Development
  o Different activities completed
  o Inform MOC/Mainpro
Group-based:
- Metrics for group performance
  o Global faculty statistics (e.g. gender)
  o Breakdown of AFP
- Leadership purposes
  o View summary of exposures and activities
  o Identify and address issues
	- Coaching and mentorship
	- 360 evaluations
	- Purposeful extractions
	- Goals
	  o Personal
	  o Leadership
	  o Career advancement
	  o Planning and demonstrating change
	- Wellness assessment
	- Comparisons
	  o Self-comparisons
	  o Compare to others
	  o Assessments (completed vs. pending)
	- Demonstrate EDI
	- Feedback and recommendations
		- Merit (e.g. AFP) distribution/leaderboard
		  o Information about Merit pay
		  o Weighting of activities
		- Information for P&T
		  o Narratives
		  ▪ Mission/philosophy statements
		- TES scores
		  o Overall TES
		  o Feedback response rates
		  o View by specific context
		- Research and grants
		  o Traditional research vs. educational scholarship
		  o Publications
		  ▪ Different types of publications
		  ▪ Reach of research
		  • Citations
		  ▪ Grants
		  ▪ Research analytics/indices
		  • Integration with existing analytics (e.g. Publon)
		  • Reviewer/editor activity
		  ▪ Knowledge translation activities
		  • Conferences/presentations
		- Personal achievements (e.g. awards)
		  o Pedagogical innovations
		  ▪ High-level summaries
		  o Total sums
		  ▪ Education hours
		  ▪ Detailed data and calculations

○ Accreditation		○ Internal vs. external contributions ▪ Community service work