Adapting Graduate Courses to Meet Industry Needs

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The higher education landscape has always been dynamic and striving to keep up in relevancy and innovations in the Industry setting. An example of a transformative change in the graduate program arena from a traditionally prevalent Master of Science program is a Professional Master of Science or Technology program (PMS or PMT). At a college in a mid-western land grant university, the PMT graduate degree is designed to help advance, or even change, the career path of professionals to reach their professional goals. The objective of PMT is to leverage the real-world experience and sharpen professional skills while providing the educational credentials sought after highly by industry. Thus, the Professional Master of Technology program (PMT) at Kansas State University Polytechnic Campus is an innovative interdisciplinary graduate degree program that helps working professionals and students expand their knowledge and skills leading to advanced careers in management, supervisory, and other professional positions.

The PMT program was introduced at Kansas State University Polytechnic Campus (KSP) in 2012. It offers common core courses in professional skills such as leadership, project management, communication and teamwork in professional settings; and tracks in areas of emphasis such as Aviation, Engineering, Technology Management, and other disciplinary areas; and a capstone experience.

One of the five core courses of the Professional Master of Technology (PMT) program at KSP is Informatics and Technology Management (COT 706). Through a modular format, the course aims to provide tools in areas of statistics, research methods and data mining. The course along with the program underwent significant transformations in years 4 and 5 of the program (Spring 2015/2016), based on advisory board suggestions and changing the landscape of industry needs; in format and content/instruction. A traditional 16-week face-to-face (FTF) class evolved to an 8-week hybrid synchronous and asynchronous format, and the content of COT 706 was modified from a stand-alone subject area to modules team-taught by multi-disciplinary instructors. The lack of course pre-requisites posed the challenge of preparing students from a variety of backgrounds and work status to be proficient in the course objectives over a short time-span. The skill-sets developed in the course were assessed through case studies, term papers, and presentations and were expected to prepare students for their capstone project thoroughly.

Objective of the paper

This paper describes a relatively new and growing program (PMT) at KSP and uses a multi-disciplinary team-taught course (COT 706) as a case study to reflect on the outcomes from implementing industry advisory board's recommendations. While low student enrollments characterize the program/course, the experience and process involved in the design of COT 706 provide valuable insights on pedagogy, team-teaching, and best practices for student learning.

The purpose of this pedagogical research study is to assess using COT 706 course whether a team-taught 8-week hybrid format accomplishes the objectives of providing the flexibility in format and skill-sets to students through multi-disciplinary course content effectively. The paper also seeks to address the following specific questions: a) How can this course prepare students from diverse backgrounds to have a general proficiency in skill sets? b) Will integration of modules such as identifying aspects of research methods and statistics, required for successfully understanding and being proficient in data mining, work better as opposed to offering a stand-alone menu of topics in research methods, statistics and data mining?

The paper is organized with a description of the COT 706 course background, followed by details of the course including the proposed structure for the course. Data from various sources are collected to analyze

the effectiveness of adaptations in the course based on industry feedback. The paper concludes with a section on lessons, challenges and possible solutions that can be adopted.

Course Setting

Evolution of the course

To keep up with the changing landscape in graduate studies and to ensure students are well prepared for the demands in the industry, the graduate faculty members at KSP initiated an advisory board meeting and worked towards adopting their recommendations in the PMT program with a review cycle of 3 years. Industry advisory boards differ in purpose and in what they contribute. According to Windsor et al. (1992) advisory board contributions are valued in the following areas: a) share advice, such as hiring trends or skills needed among graduates; b) add credibility to the program; and c) evaluate curriculum or technology trends (entire program, often measured holistically; individual course, including course competencies; graduate readiness; and facilities and technology resources). Curriculum input is the most frequently mentioned board objective in the literature and is generally considered the archetypical role of advisory boards (Genheimer and Shehab, 2009). Usually, industry representatives desire students to have up-to-date skills specific to their industry needs while academic leaders stress the importance of fundamentals and emphasize the ability and importance of life-long learning. The best scenario is when both perspectives are incorporated to make the students proficient in saleable skills and foundational knowledge. Table 1 summarizes feedback provided by the advisory board for professional skills and program delivery.

The advisory board consisting of nine professionals with various industry, government, non-profit, and business backgrounds was supportive of the structure of PMT. They advised the connection between the workplace, and prospective students can be strengthened by:

- Using workplace, not academic, terms and vocabulary to define essential concepts
- Present curriculum to mirror systems flow in industry, business, and government.
- Take advantage of cohort and module training when possible to reflect professional development
- Limit the scope of "specialty area" to only those for which there is faculty expertise
- Utilize case studies as an instructional tool when possible

The advisory board realized not every skill would require a dedicated course, but highly recommended critical skills are embedded, and essential principles (ethics, teamwork, communication, etc.) are reinforced across multiple core courses in the curriculum.

Table 1: Advisory Board feedback. (The portions in bold justify advisory board recommendations adopted for the PMT program at KSP)

Professional Skills	***NA***	***2(low)***	***3***	***5(High)***	***Comments***
1. Critical Thinking/Decision Making				**7X**	
2. Leadership/ Management Training /Organizational Behavior/Change Management/Negotiation/Conflict Resolution			**2X**	**5X**	
3. Product Commercialization		5X	2X		
4. Project Management			**1X**	**6X**	
5. Legal, Regulatory Issues, IP, and Ethics			5X	2X	Important and need to be aware of it but isn't generally a focus point

6. Strategic Planning		**1X**	**3X**	**3X**	
7. Team Management			**2X**	**5X**	
8. Professional Communications (written/verbal)			**1X**	**6X**	
9. Entrepreneurship		4X	1X	2X	This can be good or bad within a company depending on the circumstances
10. Applied Research Skills and Methods		4X	2X	1X	
11. Data Analysis/Statistics		3X	3X	1X	
12. Solving open-ended problems			5X	2X	
Program Delivery					
Face-to-face			**6X**	**1X**	
online		**1X**	**3X**	**3X**	
Weekend		3X	2X	2X	
Accelerated		2X	4X	1X	

To incorporate the recommendations of the advisory board one of the changes in the program was the creation of a modular core course, COT 706- Informatics and Technology Management. Figure 1 illustrates the timeline of changes in the graduate program curriculum and the transformation of core courses with the creation of COT 706. This course represented a unique and innovative multi-disciplinary course in two specific areas:

1. **Content:** Before the advisory board recommendation Applied Research Skills and Methods, and Statistics were stand-alone core courses, worth three credits each. The modified core course added a data mining module to the applied research method and statistics modules.
2. **Mode of Instruction:** The method of delivery also changed from face-to-face (FTF) to a hybrid format. The hybrid format allowed students to take the course online without ever stepping foot in the classroom while at the same time they were provided the option of attending class physically and meeting instructors face-to-face. The format also allowed for synchronous (e.g., video conferencing) and asynchronous (e.g., web-based course material) learning, where if synchronous setting did not work for students at remote locations, a recording was available for the students of meetings, and a further follow-up was encouraged through office hours (in person or video conferencing) or discussion boards. The duration of the course was reduced from 16 weeks to 8 weeks, making it a condensed and intensive course. This new format required students to be disciplined and organized to be able to complete the course and the entire program under two years.

At least 70% of all degree-granting institutions of higher learning in the U.S. offer some form of online distance offering and more than 2,800 colleges, and universities indicated online learning as critical to the long-term strategic plan (Allen and Seaman, 2015). While students appreciate the flexibility offered by the hybrid format, faculty acceptance of online education is consistently cited as a significant barrier, with many being hesitant due to lack of support, assistance, and training (Allen and Seaman, 2008). However, Chiasson et al. (2015) determined that faculty members perceived online teaching made them more efficient and effective teachers, even with their role shifting to a facilitator. They used more explicit instruction for clarity, enhanced content with new instructional tools and aids, and became more intentional about social interaction. Students taking responsibility for their learning is an expectation of most faculty, yet how that responsibility is operationalized varies from taking leadership roles in the content presentation to taking responsibility for studying content presented by the instructor.

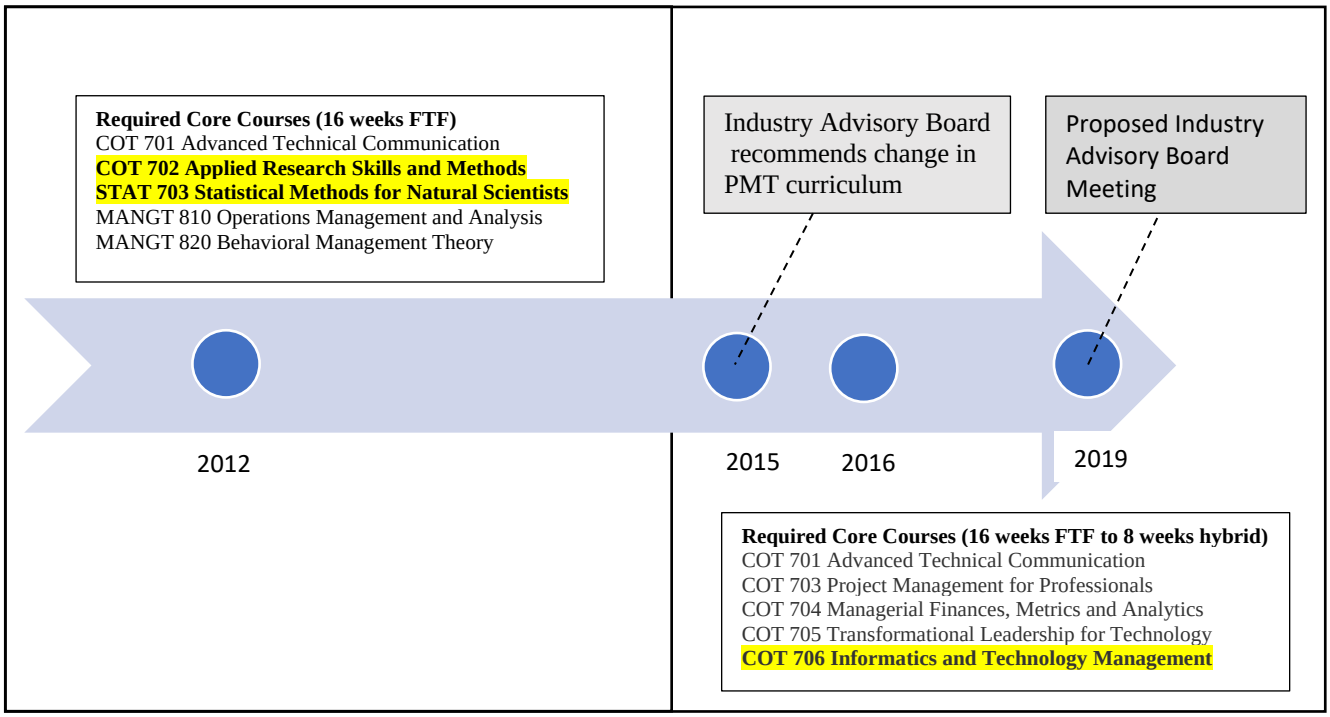

Figure 1: Timeline of changes in Graduate program curriculum

As with any novel newly introduced courses, teething problems require constant modifications in the course to better suit student's needs. Based on student feedback on teaching evaluations, the effort was made to accommodate and provide an improved learning environment to the students. The micro-changes in the course, related to the sequencing of the modules and the duration of each module. The macro-changes related to moving away from a multi-disciplinary format to a proposed inter-disciplinary set-up. Table 2 provides a visual of the changes within COT 706 in format, sequencing, and duration.

Table 2: Evolution of COT 706: Informatics and Technology Management

Spring 2015	Spring 2016	Spring 2017	Spring 2018	Spring 2019
16 Weeks FTF	*8 weeks Hybrid*			
ARM (4 weeks)	Statistics (2 weeks)	ARM (2 weeks)	ARM (2 weeks)	Integrated
Statistics (4 weeks)	ARM (2 weeks)	Statistics (3 weeks)	Statistics (3 weeks)	
DM (8 weeks)	DM (4 weeks)	DM (3 weeks)	DM (3 weeks)	
5 students	6 students	5 students	4 students	7 students

Note: ARM= Applied Research Methods, DM= Data Mining

Instructor Background and Team-Teaching

One of the salient features of COT 706 is team-teaching. Students benefit from team teaching as it can develop higher-order thinking skills by enabling students to interact with instructors who have different sets of expertise and perspectives (Bacharach, Heck and Dahlberg, 2008; Bierwert, 2011; Helms, Alvis and Willis, 2005).

Similarly, team teaching can broaden an instructor's pedagogical skills while providing opportunities to reflect more deeply on teaching and professional practice (Bacharach et al., 2008; Plank, 2011; Shapiro

and Dempsey, 2008; Shibley, 2006). Since COT 706 is multi-disciplinary and diverse, the course requires instructors that are proficient in each module. The instructors leverage their disciplinary expertise to complement the skill sets required for the modules based on their experience of working on related topics. The endeavor to extend their expertise to the module requirements has been both rewarding and efficient for the program. Considering the college is limited in faculty members with a doctorate as required in a graduate program, compensation in some cases has been an overload or considered part of the load. In terms of credit hours, the three instructors shared the credit of one each. Thus, instruction and related compensation are guided by an ad-hoc arrangement based on the newness of the program and its demands in a resource-constrained environment. Team teaching across subject and disciplinary boundaries enable instructors to encounter new content knowledge, as well as new perspectives on their expertise (Bacharach et al., 2008; Plank, 2011; Shibley, 2006). Table 3 outlines the background of instructors teaching the three modules of COT 706.

Table 3: Instructors involved and their areas of specialization

Area	Instructor	Expertise
Applied Research Methods	Dr. Jung Oh	Chemistry
Statistics	Dr. Siny Joseph	Economics
Data Mining	Dr. Raju Dandu	Mechanical Engineering

Student Background

Student composition varied greatly; some students had industry, business, government, or non-profit organization experience of 6 to 8 years while others were continuing their education after undergraduate studies. The diversity in experiences brought its challenges of preparedness for the modules and time-management skills, but the differences were extremely enriching in shared learning outcomes. The diverse background was exacerbated by the lack of pre-requisites in the course. More discussion on the challenges and possible solutions are described in a separate section.

Course Details

The three modules in the COT 706 course have varying impact on student learning. While the goal is to impart specific skillsets through the three modules, the breadth and depth of the modules varied. While applied research methods and statistics cover a broader array of topics, data mining is narrower in its focus. Figure 2 illustrates the schematic. This set-up allows students to ease into the course and systematically develop skills which are reinforced by the subsequent module. For example, the data they analyze through the case study assignment using statistical analysis is later explored using data mining software. This approach provides students the ability to understand the applications of learned skills and gives them the perspective of how the different modules are related.

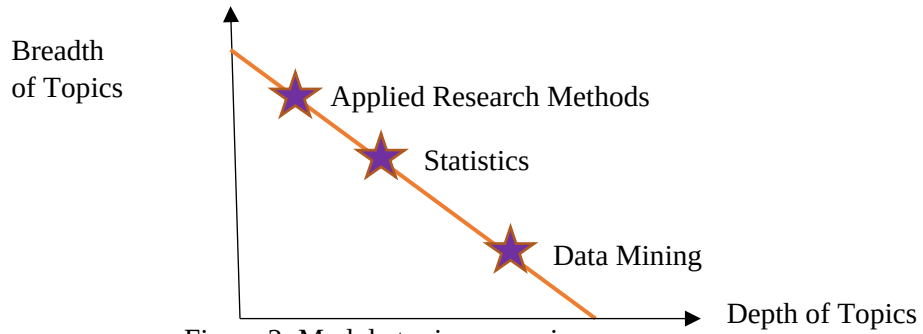

Figure 2: Module topic comparison

Selection of Topics

Three considerations mainly guided the choice of topics within each module. First is the student learning outcomes, second the absence of pre-requisites, and third the duration of each module within the course. While it is easy to fall into the trap of keeping topics superficial and broad, it is important to select the right topics and provide meaningful and marketable skills through an in-depth treatment. The objective underlying all modules is to provide the foundational skills for further exploration and inquiry if the student so requires based on their need or job requirements. Table 4 provides a list of topics covered within each module of the course.

Table 4: Outline of Topics for COT 706

Applied Research Methods	Statistics	Data Mining
Research Methodologies, Strategies, and Applied Research. Planning, Organizing, and Managing Applied Research.	Descriptive Statistics Inference Regression and Multiple Regression	Introduction to Data Mining Techniques and Tools Applications

Intended Audience

The advisory board's consensus was that the target audience for a PMT program should be *"young professionals who need additional skills to move to the next level of contribution and emerging leadership within their respective organizations. The program should try to develop professionals who are not only deeper but are also boundary spanning beyond their current horizons."*

While the advisory board saw the target audience as individuals currently working in the industry, business, government, and non-profit organizations with interest to advance in their organizations, they also recognized that some individuals might seek this degree without the required industry or experience. The advisory board recommended that these students should be required to complete an industrial or respective organization internship at some point during their degree progression to gain exposure to the work environment to help make the relevant connections between their course work and real-world experience.

For these reasons various activities of COT 706 hinges on preparing students for their capstone course and direct applicability of skills from the course to their workplace. Examples include statistical skills for data analysis, handling and analyzing large amounts of data using data mining skills, and being proficient in applied research methods to solve specific problems through an organized approach.

Sequence of Topics and Course Assessment

As shown in Table 2, the sequence of modules changed every semester based on student feedback. However, within each module, the core competencies expected to be mastered did not change. Table 5 provides a snapshot of 2018 spring semester schedule in terms of sequencing of modules, topics, and their associated weights. Student learning outcomes were assessed in a variety of ways which ensured their mastery on topics in a short period. The lack of pre-requisites; the shortened, asynchronous, and fast pace of the course; and different expectations from each module required students to be efficient with their time, disciplined and organized to be on track for successful completion of the course. The problem of ill-prepared students for modules such as statistics and data mining required them to work in teams

embracing their diversity in knowledge and skills. Peer-tutoring and accelerated self-directed learning through complementary sources ensured that the students were able to complete the course satisfactorily. Course assessments included quizzes for quick feedback to test the understanding of the material, case studies for learning and applying concepts, and presentations to demonstrate proficiency on topics.

Table 5: Sequence in which various topics within each module were presented. Each color code corresponds to topics associated with one of the modules/instructors.

Spring 2018 Weekly Schedule							
Week	**Date**	**Module**	**Topic**	**Software/ e-resource**	**Assignment**	**Points**	**Weight**
1	15 March	Applied Research Methods	Research Methodologies, Strategies, and Applied Research	SAGE Research Methods Online	Content embedded-Quiz, Discussion	70	25%
Spring Break							
2	29 March		Planning, Organizing, and Managing Applied Research		Journal paper analysis, Mindmap	100	
3	5 April	Statistics	Descriptive Statistics	Microsoft Excel	Case Study 1 & 2	200	35%
4	12 April		Inference		Case Study 3 & 4	200	
5	19 April		Regression and Multiple Regression		Case Study 5	100	
6	26 April	Data Mining	Introduction	Rapid Miner			40%
7	3 May		Techniques and Tools		Term paper 1 and Presentation	100	
8	10 May		Applications		a) Term paper 2 and Presentation b) Rapid Miner practice exercise presentation	100 200	

Proposed Integrated Course

Many academic and scientific institutions recognize the need for interdisciplinary training programs that prepare future scientists, leaders, and managers to address complex problems (Zarin et al. 2003, CFIR 2005). Many groups have independently concluded that interdisciplinary training is an important new direction for graduate education (Nyquist and Woodford, 2000; Golde and Walker, 2006; Woodrow Wilson Foundation, 2005). Advocates portray interdisciplinary courses as more engaging than disciplinary courses because they capture students' intellectual interest and help them connect information from discrete disciplines (Lattuca, Voight and Faith, 2004). Some argue that interdisciplinary study better prepares students for work and citizenship by developing higher-order cognitive skills such as problem-solving, critical thinking, and the ability to employ multiple perspectives (eg., Hursh, Hass and Moore,

1983; Newell, 1990; Newell and Green, 1982). Interdisciplinarity is often defined as the integration of existing disciplinary perspectives. Lattuca (2001) derived a typology of four different forms of interdisciplinarity based on interdisciplinary research or teaching approach. The model of interdisciplinarity proposed for COT 706 is *synthetic interdisciplinarity* defined as a course where instructors combine theories, concepts, and research methods from different disciplines; but the contributing disciplines remain identifiable, revealing relatively bounded content areas and perhaps distinctive methods of inquiry.

Based on positive feedback from the students for an interdisciplinary course where the course modules are integrated, it is proposed to transform stand-alone multi-disciplinary modules to be integrated in Spring 2019. Typically, the multi-disciplinary format has 8-weeks with an allocation of stand-alone modules at 2-3-3 weeks (applied research methods for two weeks). All modules have skills mastery of the module accomplished through assignments designed for the module. Multidisciplinarity can be distinguished from interdisciplinarity; multidisciplinarity is less integrative, often a temporary or weak combination of contributions from multiple disciplines (Berger, 1972, Chubin et al., 1986; Committee on Facilitating Interdisciplinary Research, 2004). Stokols et al. (2008) make the distinction in more process-oriented terms: Multidisciplinarity is a process in which scholars from disparate fields work independently or sequentially, periodically coming together to share their perspectives for purposes of achieving broader-gauged analyses of common research problems. Interdisciplinarity is a more robust approach to scientific integration in the sense that team members not only combine or juxtapose concepts and methods drawn from their different fields but also work more intensively to integrate their divergent perspectives, even while remaining anchored in their respective areas.

The proposal to integrate the course modules features designing a final integrated assignment which incorporates aspects of the three modules seamlessly. Table 6 provides an outline of how the allocation of 8-weeks for the three modules can change to include an integrated assignment. This format allows for the introduction of individual modules and associated assignments to foster learning and application. Figure 3 provides more details on the integrated assignment and how the three modules play into the assignment. Colwell (2009) attests interdisciplinary group-project format may be suitable as a research requirement for a course-based master's degree or professional-certification program.

The proposed change from multi-disciplinary to an inter-disciplinary course also has bearings on the team-teaching format. According to the array of models in use at the University of Michigan (http://www.crlt.umich.edu), the current model of team-teaching for COT 706 can be considered 'sequential' which is described as instructors collaboratively setting the basic structure of the course but not sharing plans for individual class sessions. Each instructor independently implements their module and determines the material to be covered and the teaching modalities to use. The proposed model of team-teaching corresponds to 'specialty' where instructors collaboratively plan the course and individual class sessions but teach to their expertise within or across class sessions. Assignments are jointly planned, though grading may be split to reflect zones of expertise.

Table 6: Proposed integrated course module 8-week outline

Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Introduction Orientation Syllabus	Applied Research Method (Quiz)	Statistics (Assignment)		Data Mining (Assignment)		**Integrated Final Assignment**	

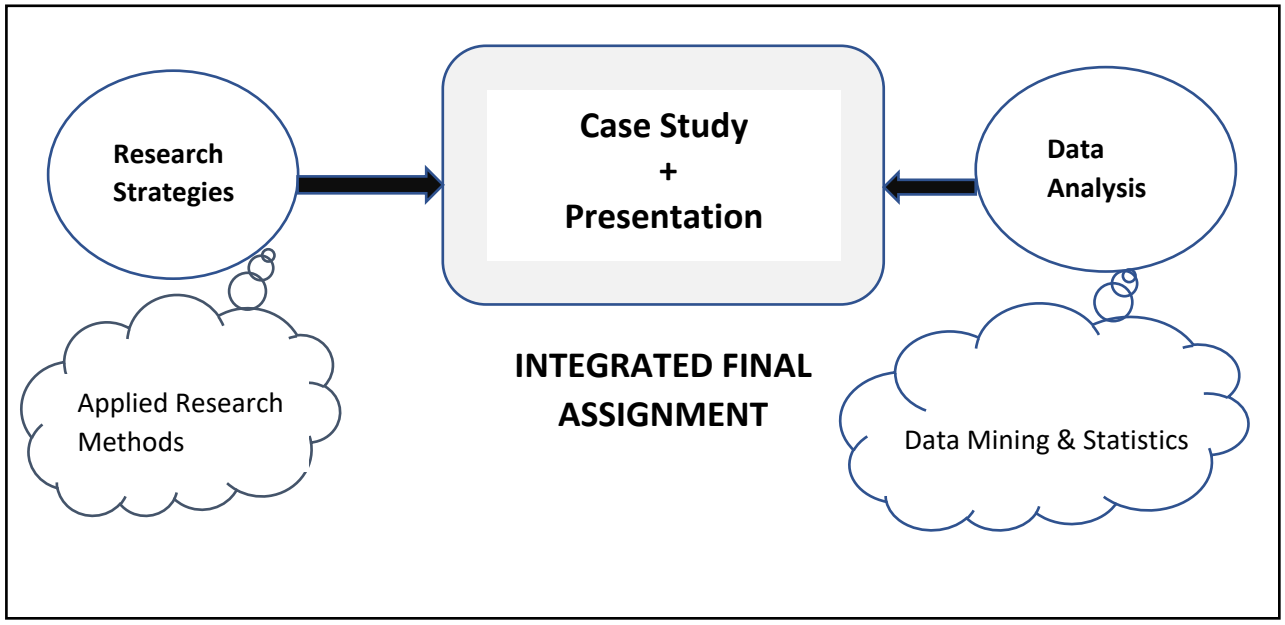

Figure 3: Proposed integrated modular course assignment

Data

This section investigates the effectiveness of the COT 706 course in meeting industry needs, from the perspectives of students and instructors. The methodology includes an analysis of student alumni survey, student grade book, and teaching evaluations.

Student Survey

All student alumni from the induction of COT 706 as a core course in the curriculum were contacted, i.e., from Spring 2015 to Spring 2018. Students were requested to complete a Qualtrics survey administered online to provide feedback on their experience with the course, comment on the proposed changes in the course and the applicability of skills learned in the course to their profession. The response rate was 68% with a sample size of 19. While the sample is small for conclusive analysis, the responses are meaningful in providing critical insights about the course and serve as a good case study for the adoption of similar format and styles in institutions elsewhere. Questions asked in the survey, and the demographics of the student profile are in the appendix.

The results of the survey indicated the following:

1. The 8-week hybrid format was recommended by 80% of the respondents over the 16-week face-to-face option based on their experience.
2. The modular course format of applied research methods, statistics, and data mining is preferred over a stand-alone option of these courses by 55% of the respondents.
3. The proposed transformation of an independent modular format of COT 706 (multi-disciplinary) to an integrated course, with more flow between the modules in terms of a summative assignment which integrates concepts from all three modules, is recommended by 90% of the respondents.
4. 60% of the respondents answered in the affirmative that the course provided skills for PMT degree's capstone.

5. The emphasis of the individual module was recommended to change from the status quo as (Table 5 provides current weights of each module)-
    - Applied Research Methods: 73% wanted the emphasis as is and the remaining wanted an increased emphasis
    - Statistics: 45% wanted an increased emphasis, 36% wanted no change in emphasis while the remaining indicated less emphasis
    - Data Mining: 82% wanted an increased emphasis, and the remaining wanted no change.
6. The impact of COT 706 on three criteria measured at a maximum of 100 points was averaged to provide the following points:
    a. Applicability of skills learned in the course to career goals -72
    b. Level of rigor and scholarship – 77
    c. Assistance in finding a job after graduation - 52.

Perceived progress by students of applying critical thinking and problem-solving skills when analyzing complex industry problems (PMT program at KSP's SLO #6) is measured in Table 7. The numbers in the table correspond to the number of respondents to this metric, compiled from student alumni survey and exit surveys taken by students upon graduation. Five students indicated their perception of knowledge and professional skills declined after taking the course as opposed to 8 who indicated the course enhanced their perception of knowledge and skills.

Table 7: Perceived progress with COT 706

		Perceived knowledge and professional skills (SLO #6) **after** taking COT 706		
		Low	Medium	High
Perceived knowledge and professional skills (SLO #6) **before** taking COT 706	Low		2	
	Medium	4	5	6
	High		1	4

Teacher Evaluations

The learning environment to a large extent is defined by teaching effectiveness. Even though the onus on learning ultimately falls on students such as their interest, efforts, background, etc., the impact of instructors in enabling and facilitating this learning is critical. For this reason, teaching evaluated by students taking the course can provide valuable insights concerning the accomplishment of course objectives. Table 8 tabulates student assessment of interest in the course before enrolling, increased desire to learn about the subject as the course progressed, their effort to learn in the course, amount they learned in the course and effectiveness of the teacher. The response rates in Table 8 correspond to enrollment numbers mentioned in Table 2. Figure 1 illustrated how the advisory board recommended changes in core courses for the program and the format from 16-weeks FTF to 8-weeks hybrid. To be able to distinguish and compare student experiences in similar content area but different formats, Table 8 also documents teaching evaluations of stand-alone applied research methods 16-weeks FTF *course* (COT 702) to its *modular* counterpart. It is worth noting there is no change in the instructor across the *course* and *modular* format. Table 8 further allows comparison of teaching effectiveness between COT 706 16-weeks FTF with 8-weeks hybrid.

Statistics was a stand-alone core course before 2015 as well; however, data on teacher effectiveness is not available for the course. The reason being that students could take the course from a different department

(Department of Statistics) and it was deemed as meeting the requirements of the program. Data mining was a new addition based on the recommendations of the advisory board to the PMT curriculum.

Table 8: Teaching Evaluations for each semester

Maximum score = 5.0			**Interest in the course before enrolling**	**Increased desire to learn about the subject**	**Effort to learn in the course**	**Amount learned in the course**	**Overall effectiveness of the teacher**
16 weeks	**Spring 2012** (100% response)	Applied Research Methods (COT 702)	4.0	4.7	4.0	4.3	3.7
	Spring 2013 (100% response)	Applied Research Methods (COT 702)	3.5	4.0	4.0	3.5	3.5
	Spring 2014 (100% response)	Applied Research Methods (COT 702)	4.0	5.0	4.0	4.7	4.3
	Spring 2015 (83% response)	Applied Research Methods	4.2	3.8	4.2	3.6	3.8
		Statistics	4.6	4.6	4.4	4.2	4.8
		Data Mining	4.4	4.4	4.4	4.2	4.5
8 weeks	**Spring 2016**	No Teaching Evaluations collected					
	Spring 2017 (100% response)	Applied Research Methods	2.5	2.5	3.0	2.5	3.0
		Statistics	3.0	2.5	4.0	3.5	4.0
		Data Mining	3.0	2.5	3.5	3.0	3.5
	Spring 2018 (50% response)	Applied Research Methods	4.5	4.5	4.5	4.5	5.0
		Statistics	4.5	4.5	5.0	4.5	5.0
		Data Mining	4.5	4.5	4.0	4.0	5.0

Student Gradebook

Apart from documenting overall student progress in COT 706 (Figure 4), a comparison is also made of student grades across applied research methods (COT 702) stand-alone *course* and *module* (Table 9). For COT 706, about 75% of the students got a grade of A or B. When applied research methods topics are compared across 16-weeks FTF, 4-weeks FTF, and 2-weeks hybrid; 2-weeks hybrid resulted in more A's than others. The successes in this module can be explained by the design of tailored material with embedded assessment activities, that are designed to be completed satisfactorily by students who have the attitude to learn and keep up with time-sensitive quizzes and discussions. The weight of the modular course is relatively lower than the other modules as well, which could incentivize students to maximize their grades where possible in an efficient manner.

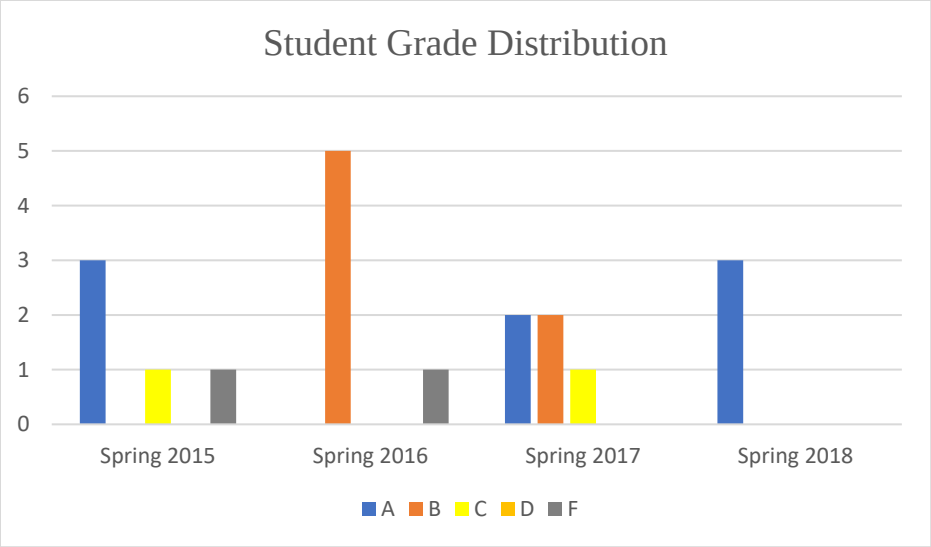

Figure 4: Student grade distribution for COT 706

Table 9: Student grade comparison between COT 702 *course* and COT 706 - Applied Research Methods (ARM) *module* only

		A	**B**	**C**	**D**	**F**	**I or W**
COT 702 16 weeks	Spring 2012	2	1				
	Spring 2013						2 I
	Spring 2014		2				1 W
COT 706 (ARM) 4 weeks	Spring 2015	2	1	1		1	1 W
COT 706 (ARM) 2 weeks	Spring 2016	4	1				1 I
	Spring 2017	5					
	Spring 2018	3				1	

Data Analysis

This section tests the effectiveness of adaptations in the course based on industry feedback. The adaptations correspond to the change in format and content. To test this hypothesis applied research methods *course* is compared to the applied research methods *module* across six years, keeping course/instructor constant across years. The content, however, changes in depth over 16-weeks and 2-weeks.

To test the hypothesis an econometric model considers satisfactory student grades (grade A or B) to depend on variables such as time-frame in weeks (16-weeks, 4-weeks, 2-weeks), format of the course/module (FTF or hybrid), effort to learn in the course/module, and amount learned in the course/module.

The dependent variable is labeled as "satisfactory" based on the number of students earning grades "A" and "B" of the total students enrolled for that year. This information is obtained from student grade book, and the data for the remaining independent variables are obtained from teaching evaluations. The model can be written as a linear regression equation:

$$RS = \beta_0 + \beta_1 W + \beta_2 F + \beta_3 E + \beta_4 A + \epsilon$$

Where β are the regression coefficients. The variables are defined as- W corresponds to weeks, F is the format of the course, E is the effort to learn, and A the amount learned. The following results are obtained shown in Table 10:

Table 10: Regression results with $R^2 = 0.72$

	Coefficients	*t Stat*	*P-value*
Intercept	2.71	1.2	0.45
W	-0.04	-0.8	0.58
F	-0.03	-0.2	0.90
E	-1.04	-1.3	0.42
A	0.65	1.3	0.43

All variables significantly affect student success. In other words, time frame in weeks, format of course/module, effort to learn and amount learned in the course/module significantly explain student's satisfactory grades.

The results can be interpreted as more weeks for applied research methods has a detrimental effect on student grades, so a 2-week format works better than a 16-week format. Greater FTF interaction does not improve student success indicating a hybrid delivery helps students better. Student effort is inversely related to their success in the applied research methods module and finally, the more the students learn, the better they perform in the course. The negative effect of effort can be explained by the shift in effort from applied research methods module to the other modules for the later years, considering other modules have more weight in the course. Also, with supplemental online resources specifically designed for the 2-week *module*, the amount of effort required is relatively lower than a stand-alone *course* (COT 702) because the content has been selectively modified to focus only on foundational topics. However, a pathway to further in-depth exploration of research methods areas is provided in the module, for students to pursue based on their needs and interests. Amount learned in the course can also be considered as a proxy for teacher effectiveness. So, effective teachers can play a role in improved outcomes for the student.

Overall, this section demonstrates that the changes proposed by the advisory board in the graduate program curriculum have been effective in improving student outcomes.

Lessons, Challenges and Possible Solutions

Course feedback

Student feedback comments from the alumni survey and teaching evaluations endorse instructor efforts, course design and provide suggestions that could be incorporated to enhance the student experience in the course. Students appreciated the professionalism, promptness and timely response to their queries, especially because this was a hybrid course with rare FTF interactions. They considered the choice of topics to be relevant to their career. They commented on the intensity of the course in terms of the vast amounts of information needed to be processed and reviewed for assignments, as well as acclimatizing to the expectations of different instructors, all in a condensed time-frame. There were mixed suggestions of increasing time and emphasis for certain modules over others. Some suggestions for different software packages were also mentioned based on their needs at the workplace.

Challenges

The nature of the program is such that students develop some core competencies and then specialize in areas of their interest. Students are prepared for the specialization courses with either prior work experience in the area or undergraduate degree in the area. When it comes to developing core competencies, the wide disparity in the student's background gets magnified. Undergraduates with a strong technical background may find themselves better prepared than others for some classes, with some topics even being redundant for them. On the other end of the spectrum, there are working professional students who have mastered skill-sets such as managing projects, and teamwork. Thus, it is a challenge to prepare students from a variety of backgrounds and work status to be proficient in the course objectives in a short time-span. The condensed time-frame of 8-weeks make the courses intense and requires students to be disciplined, organized and prepared to deal with course requirements in a timely manner. The rigor and demands of the courses can easily overwhelm students with responsibilities, working students and generally unprepared students.

Solutions

Feedback from other core course instructors of the PMT program who also changed the format of their course from 16-weeks FTF to 8-weeks hybrid has been to develop an orientation module for all incoming students. An orientation module is similar to boot camps which are considered essential to bring together a diverse student body. The University of Michigan developed such a boot camp to impart a common language and mindset among the diverse cohort of incoming students to their Masters in Entrepreneurship program. This orientation should map the sequencing of courses as well as outline expectations in each course (especially courses with no pre-requisites) so that students are better prepared in managing the course requirements as well as their time between work and academics. Other avenues for mitigating challenges such as wide disparity in their background, includes building student cohorts/teams either using discussion boards or through the orientation program. Students could be provided with information about introductory textbook materials during the orientation which would help students review or fill in gaps in prerequisite background knowledge. Instructors can provide examples by being a model of productive teamwork and hence imbibe successful collaborations between students (Carpenter, Crawford, and Walden, 2007; Helms et al., 2005; Yanamandram and Noble, 2006). Overall students will also benefit if there is more dialogue between instructors across the program to foster skill transfer from course to course culminating in a balanced development of skills.

Wagner et al. (2012) describe the development of an interdisciplinary, distributed graduate course model which combines the best of local teaching, distance learning, and experiential learning. Their results show instructors believe interdisciplinary material is best team-taught and often provides professional development opportunities to instructors. Students consider their interaction with experts from different fields as an inspiration to think broadly on how to approach the field from many different angles. The PMT program at KSP is designed to be an interdisciplinary graduate program where the skills developed across courses is expected to be applied in the capstone project. To align with the program objectives and to further increase the impact of the program, COT 706, a core team-taught course has been proposed to transition from a multi-disciplinary to an interdisciplinary format. Borrego and Cutler (2010) provide a template of constructively aligned interdisciplinary graduate curriculum that can be followed for improved outcomes. They recommend listing learning outcomes and matching assessment evidence and learning experiences with the learning outcomes.

Conclusion

This paper describes the changes made in the curriculum of the PMT program at KSP based on industry advisory board's recommendations, both in content and format. Using COT 706 as a case study, which embodies the prescribed changes as well as adds a unique dimension of team-teaching in the program, data is collected from various sources such as student alumni survey, teaching evaluations and student gradebook to determine the effectiveness of the changes made in the program and course. Data analysis supports the transformation from a 16-week face-to-face to an 8-week hybrid format.

Recognizing the challenges faced by both instructors and students of the program provides valuable lessons to ensure improved outcomes. Diversity in student background should be leveraged to provide opportunities in shared learning. Communication between instructors of common challenges in the program should lead to solutions such as developing an orientation program to build student cohorts. Efforts in revising a program to impart marketable skills for students in the industry should be matched by creating an environment for students to thrive and be successful.

The plan for COT 706, going forward is to transition from a multi-disciplinary content area to inter-disciplinary. This will be achieved primarily through an integrated assignment which will tie-in content from the three modules- applied research methods, statistics and data mining. The program itself will benefit from the next round of industry advisory board meeting scheduled later this year. The platform will be used to reflect and report on the successes/lessons from the program based on prior recommendations.

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Appendix

Student Survey Questions:

1. How has your knowledge and skills developed with COT 706?
2. In Spring 2015 COT 706 transformed from a face-to-face 16-week to an 8-week hybrid format. Considering your experience, do you recommend the 8-week hybrid format?
3. Do you prefer stand-alone courses of Applied Research Methods, Statistics, and Data Mining as opposed to the modular course format that you experienced?
4. The independent modular format of COT 706 is being proposed to be further transformed to an integrated course, where there would be more flow between the modules in terms of a summative assignment which integrates concepts from all three modules. Would you recommend an integrated course?
5. Does/Did the course prepare you for PMT degree's Capstone course?
6. How would you change the emphasis in COT 706 for the three modules?
7. How would you rate COT 706 in a) Applicability of skills learned in the course to your career goals, b) Level of rigor and scholarship, c) Assistance in finding a job after graduation?
8. What were the one or two <u>things you liked best</u> (greatest strengths) about COT 706?
9. What were the one or two <u>things you liked least</u> (greatest weaknesses) about COT 706?
10. Additional comments or suggestions?

Demographics: