Design and Evaluate the Factors for Flipped Classrooms for Data Management Courses

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***Abstract*—This Research to Practice Full Paper presents a framework to evaluate and design flipped classroom activities for data science and management courses. Variants of flipped classrooms have been employed in STEM fields with great success in students' learning outcomes. Research shows that flipped classrooms would improve students' learning if it is implemented following rigorous procedures of an efficient instructional design. As a result, one of the critical focus of current flipped classroom research is what factors educators need to consider when designing a flipped learning environment. Currently, educators incorporate various factors such as "pre-recorded video lecture", "group activity" as a trial and error basis and adjust these factors based on their own experience and students' feedback. On the other hand, the emergence of big data expects a new graduate to demonstrate mastery of concepts and skills for data acquisition, management, and analysis of inference from data when they enter the workforce. Currently, there is no systematic approach available to design a flipped classroom that is for the data science and management courses. In this research, we develop a framework first to investigate and evaluate the flipped classroom factors mentioned in the literature and identify a few that are most relevant to the two data management courses at our institute. Then, we classify each course topics into broader categories. So that the flipped classroom model can be developed for each category. For the flipped classroom for each category, we identify the pre-class and in-class activities to meet a certain learning objective for that topic category for each course. To evaluate the effectiveness of different factors as well as our flipped classroom models, students' performance data, interviews, and surveys are conducted. This process is transformative and can be employed by other STEM disciplines to find the most influential factors to design effective flipped learning classrooms.**

***Index Terms*—Flipped Classroom Model, STEM, Data Science and Management**

I. Introduction

Literature shows that the flipped classroom improves students' learning and teachers' satisfaction. However, research on flipped classrooms shows that positive outcomes from flipped learning models depend on their design [1], [2]. Studies show lower performance in the flipped class is often due to the lack of pre-class preparation accountability. There is also evidence about the importance and the need to design and align the pre-class and in-class activities. Data on flipped classroom in STEM shows that the probability of a flipped learning case to be successful increases when (a) overall design is carefully done in analyzing the needs and determining the level of flipping, (b) course contents are intentionally designed to meet the requirements of a flipped learning environment and the diversified needs of students, (c) technology tools are chosen appropriately to deliver content materials or perform learning activities, (d) active learning strategies are integrated into the content design or activity design, and (e) all the designs take into consideration how to motivate student learning. As a result, one of the critical focus of current flipped classroom research is what factors educators need to consider when designing a flipped learning environment. These factors vary based on subject matters, learners' needs, availability of resources (faculty, technology), and others. Different disciplines might need different flipped classroom design to facilitate students' learning.

Currently, educators incorporate various factors such as "pre-recorded video lecture", "pre-class work", "group activity" as a trial and error basis, and adjust these factors based on their own experience and students' feedback. In most cases, educators design flipped classes based on by utilizing factors they are interested in, such as overall design, design of information, design of technology use, active learning, motivation, specialized guidance, and self-regulated learning, and others. Currently, there is no systematic approach available to design flipped classroom for courses in data science and data management field. The objective of our work is to investigate and identify the influential factors for a flipped classroom design for courses related to data science and data management. First, we gather twelve literature about flipped classroom design and implementation in the STEM fields, and summarize them based on what factors they used and their outcomes. Then, we selected some factors mentioned in the literature to implement with our two data management courses at the sophomore and senior levels: CIT 21400 Introduction to Data Management and CIT 44400 Advanced Database Design.

To evaluate each flipped classroom factor, we analyzed students' performance data. The students' opinions (positive or negative) were collected regarding the usefulness (or effectiveness) of each factor, such as pre-class activity, in-class activity, group work, towards their learning outcomes through surveys and focus groups. These results can further help us reframe the factors that can be used in the following semesters to do a compare and contrast analysis. We believe that through an iterative evaluation of the factors over a few semesters, we can identify the most influential factors to be used for our data science and management courses. The success of this research can provide a framework and methodology that can be used by any disciplines or sub-disciplines STEM courses where flipped classrooms can be implemented to improve students' learning, motivation, and knowledge retention.

The rest of the paper is organized as follows. Section II presents the background and related work about flipped classroom and its application to STEM courses. Our approach of flipped classroom design and implementation is given in Section III. Section IV shows the research results and discussion of the results. Finally, we conclude this research in Section V.

II. Background and Related Work

The flipped classroom model is increasingly utilized in higher education, but the use of the flipped classroom has received less attention in STEM (science, technology, engineering, and mathematics) [1]. Historically, due to the complicated subject matter and the technical nature of STEM disciplines, educators mostly rely on traditional lecture-based teaching methods [3]. In lecture-based models, educators spend class time explaining fundamental technical concepts with the use of examples, walking through the solutions to various problems. Then they are assigning homework to supplement this learning, which causes the practice and application to happen outside of the classroom in the form of homework with delayed feedback from the faculty. This traditional model does not permit sufficient time for student-student or student-faculty interactions during class. It has been observed by STEM educators that a lecture-based approach does not engage some students or keep them interested [3]. On many occasions, it has been found that students performed better in flipped classroom models compared to the traditional lecture-based models. Researchers found it is even harder to keep students interested by competing with the invasion of social networks and other smartphone notifications for a more extended class with traditional teaching [4][8]. Students also have difficulty retaining and applying their knowledge. To address these issues, educators have begun utilizing a flipped model in STEM education [4]–[8].

In a flipped classroom, students often gain technical knowledge through online videos that prepare them to participate in in-class activities. These videos contain the explanation of concepts, examples, and problem walkthroughs. In-class activities are designed to answer questions or uncover common misconceptions, discuss complex topics, and work with students [6], [9]. Class activities also contain tasks that help students to learn and practice skill sets for mastery of concepts. In this learning environment, students get immediate real-time feedback from other students and faculty during class. Educators notice that students learn the concepts better when applied directly to a specific problem, and in the group learning environment, they learn to teach each other, which is the highest level of learning comprehension [6], [7]. However, research on flipped classrooms shows that positive outcomes from flipped learning models depend on their design [1], [2]. Instructional design plays a significant role in student experience and performance. Researchers [3] found that educators have "flipped" incorrectly (for example, by having students watch three hours of video lecture outside of class) and have been frustrated with the flipped classroom concept. As a result, a key focus of current flipped classroom research is what factors educators need to consider when designing a flipped learning environment [2]. Presently, to design a successful flipped classroom, educators include various factors such as a pre-recorded video lecture with pre-class activity, a follow-up quiz on the pre-class work, an in-class activity, and in-class group activity.

Studies [7], [9] show that the following factors have a significant impact on the success of a flipped classroom model: 1) out-of-class and in-class elements must be carefully integrated for students to understand the model and be motivated to prepare for the class; 2) shorter, rather than longer videos; and 3) pre-class activities must be coupled with quizzes or follow-up tasks to assess the student's understanding. A successful flipped classroom design requires significant effort and time on the part of the faculty [9]. However, for all domains, the same design might not work. The different domains might need different designs based on the nature of the subject matters, students' needs, resource availability, and others. Currently, no work shows which domain needs what type of design.

In STEM education, the flipped classroom model is used mostly used to teach pure science and mathematics courses. This model has rarely been used to teach subjects from the applied science, technology, and engineering fields [18]. In a recent study of fifty-eight peer-reviewed research studies on flipped learning in the higher education STEM disciplines, results indicate that only about 6% of these studies were conducted in the applied science, technology, and engineering domains [18]. There are a few works where a flipped model has been used successfully in the applied science, technology, and engineering disciplines [4]–[6], [8], [11], [13]. The existing studies on the flipped classroom on technology and engineering also reported high student satisfaction and increased performance [1], [4], [5], [8], [11], [13], [19]. In a recent review of research on the flipped learning method in engineering education, Karabulut-Ilgu et al. [20] analyzed sixty-two articles from the engineering domain. They found that an increase in the number of engineering courses being converted into a flipped format after 2012. One of the most commonly cited benefits of flipped learning was flexibility. An added value of the flipped approach was able to re-watch the lecture videos. Another benefit of this student-centered instructional approach is that it allows students to work on complex exercises where students can interact with each other and with the instructor. This synthesis concluded that students enjoyed working with their peers. This approach also improves student engagement. Some of the challenges cited in this study, such as heavy workload for faculties and technical issues, can be addressed adequately. Karabulut-Ilgu et al. [20] recommended educators to gradually convert their courses rather than doing it all at once because material development might be overwhelming.

Different from the previous research, we build our approach to identify influence flipped classroom factors for data science and management. Since no current work shows the impact of factors for a flipped classroom implemented for data science and management courses, in this work, we propose a framework first to identify the relevant factors for designing a flipped classroom for data science and management courses. Then, the factors are evaluated by the students of two different data management courses.

III. Our Approach

In this work, we investigated a systematic approach to find influential factors for designing flipped classrooms for both sophomore and senior data management courses to be successful. We first gathered relevant literature and summarize the flipped classroom factors used in the literature for both

TABLE I
Flipped Classroom Design Factors for Junior and Senior Courses In the Literature

Author	**Flipped classroom activities (factors)**	**Course Level**	**Major Outcomes**
C. E. Davenport [5]	Pre-class activity: • Complete reading from textbook • Watch online videos In-class activity: • Complete a short quiz to test knowledge • Work on homework assignment in a collaborative manner with the assistance of other students and the instructor	A computer programming course in Meteorology for senior undergraduate and graduate students	Students felt that the flipped classroom improved their critical thinking skills. Instructor felt that students had stronger coding skills at the end of the semester using the flipped classroom method as opposed to traditional lecture. Students recommend for a small in-class review.
Riabov and Cupak [6]	Pre-class activity: • Read articles from the peer-reviewed academic journals to explore modern computing technologies and apply those in capstone projects In-class activity: • Present findings from assigned articles • Participate in discussion • Work on different phases of the project with the help of the instructor	A Capstone project course for senior students	This approach contributes to the success of students' efforts in development of high-quality capstone projects.
Coyne et al. [10]	Pre-class activity: • Watch videos which were twenty-minute summary of the lecture content • Read notes, write blog comments and read papers before the class In-class activity: • Discussion on the lecture • Collaboration and discussion on academic reading and writing to develop critical thinking skills • Use technology to facilitate collaboration	A course on Media and Culture with an emphasis on digital media for postgraduate level university students	Students prefer to watch recordings of lectures where they can see the lecturer in the video as well as the slides, screen interactions, or other material. Students seemed to be much more engaged than in previous years. Attendance was high and there was a lot of group discussion.
N. Paez [4]	Pre-class activity: • Watch video on lecture and video on how to use a specific tool • Complete assigned reading from various resources • Complete the knowledge check quiz In-class activity: • Perform interactive activities such as exercises and discussions	A software engineering course for senior students	Students considered it more effective and engaging than the traditional lecture-based approach.
Redekopp and Ragusa [11]	Pre-class activity: • Watch video lectures before coming to class • Take a brief online assessment quiz associated with the online lecture content. In-class activity: • Perform pieces of their homework or projects where an instructor or TA monitor progress, answer questions or address issues	A computer organization and architecture course for junior level undergraduate students	This approach increased students' problem solving and modeling skills in computer engineering.
Wasserman et al. [12]	Pre-class activity: • Watch video lecture • Complete reading In-class activity: • Spend time on more conceptual activities and homework problems	A calculus course for sophomore or junior students.	Similar performance on more procedural problems and small to moderate gains for the flipped students over their traditional counterparts on more conceptual exam problems.

TABLE II
FLIPPED CLASSROOM DESIGN FACTORS FOR FRESHMAN AND SOPHOMORE COURSES IN THE LITERATURE

Author	**Flipped classroom activities (factors)**	**Course Level**	**Major Outcomes**
Bachnak and Maldonado [8]	Pre-class activity: • Review and understand the assigned chapters In-class activity: • Briefly review the assigned material and answered a few questions • Take a short open-book quiz • Help each other master the assigned material and solve related exercises • Go over homework solutions, clarify misconceptions	A course on principles of electrical engineering for freshman students	The approach was favored by the majority.
S. Liu [13]	Pre-class activity: • Watch video lecture In-class activity: • Question answering for 5 minutes • Complete a 5-10 minute quiz to check knowledge • Do interactive learning activities individually or in groups. Activities consisted of 3 to 5 assignments with increasing level of difficulty	An engineering computation course for sophomore students. First Course in Computer Science for Engineers.	The flipped section yielded much more A's, less B's, and less C's compared to lecture based section.
Fox-Turnbull et al. [14]	Pre-class activity: • Watch video In-class activity: • Work collaboratively for problem-solving	A course to teach first and second year engineering students the topic Dynamic	Students liked video lectures. Students appreciated the emphasis on collaborative problem solving. Students suggested to add online forum and shorten the videos lectures.
Cronhjort et al. [15]	Pre-class activity: • Watch a short online video • Complete the integrated quizzes In-class activity: • Spend 50% of time on active student work or student discussions • Use the remaining time to sum up student exercises and student discussions	A calculus course for freshman and sophomore students	On the Calculus Baseline Test, the normalized gain was 13% higher in the flipped-classroom group. The flipped-classroom group scored significantly higher on the engagement and performed much better than expected on the final exam.
Ponikwer and Patel [16]	Pre-class activity: • Watch video • Use the online blog to post questions or flag up areas of difficulty In-class activity: • Use 15 min to answer o any frequently occurring questions in the online blog • Utilize rest of the time for problem-solving activities • Work in smaller groups. A student with the higher confidence on the topic worked as a mentor for the group	A course on fundamentals of analytical chemistry for freshman students	Students found that video lectures were useful (particularly mentioned by international students). Students took active responsibility for their learning and were satisfied with being able to learn at their own pace and conduct problem-based activities in classroom sessions.
Lori Sowa and Thorsen [17]	Pre-class activity: • Watch video accompanied by annotated PowerPoint slides • Complete the self-test quiz problem at the end of each video • Use the discussion thread to post questions and get responses from other students and the instructor In-class activity: • Deliver mini-lectures • Perform problem solving • Encouraged to work in groups	A course on Thermodynamics for sophomore students	Average exam scores showed substantial gains and approximately 88% of students agreeing on the question "I would like to take more classes using this teaching style".

the sophomore and senior courses and their applicability to the data management courses. Then, we designed flipped classrooms for both data management courses using selected factors and evaluate their effectiveness.

A. Flipped classroom factors identification

Based on our literature review, we find that the flipped classroom design and implementation have been done in computer programming courses and engineering courses, but not much has been done in the courses in data management and data science domain. The emergence of big data expects a new graduate to demonstrate mastery of concepts and skills for data acquisition, management, and analysis of inference from data when they enter the workforce. In data science or data management, the standard and basic courses are in the following areas: data management and processing, data-driven

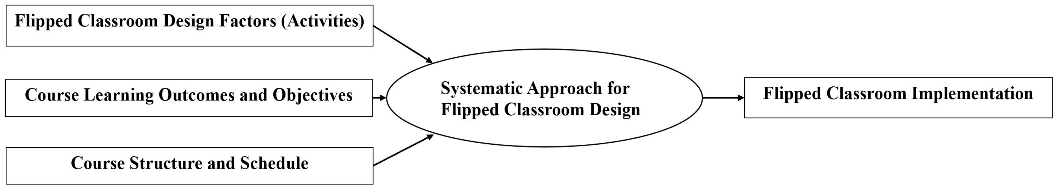

Fig. 1. Systematic Approach for Flipped Classroom Design

application design and implementation, data modeling and analysis, machine learning algorithms, and visualization tools, which raises the questions: What type of data management and data science courses are suitable for the flipped classroom design? How to find the most impact factors and design the flipped classroom using these factors according to the course objectives, outcomes, and schedules. In this work, we focus on the data management and processing, as well as data-driven application design courses and investigate the existing factors in the literature for STEM flipped classroom design and identify the relevant ones to the data management courses.

We first investigate the existing literature related to flipped classroom design in STEM and identify the relevant factors to the data management and application design courses at both a sophomore and senior level. Table I and Table II present the most relevant literature, the involved factors and main outcomes. Table I and Table II show that irrespective of the course level, in most cases, to design flipped models, educators use short video lecture as pre-class activities. In most cases, a low stake quiz is associated with the videos to encourage students to complete the pre-class activity and give instructors ideas about students' understanding of the topics. Educators also often use a discussion forum for question answering. Regardless of course level, class times are commonly used for small reviews and conceptual activities collaboratively. Based on the literature, We then develop a systematic approach that can be used to evaluate and determine whether a flipped classroom is suitable for a data management course, and to determine how to select flipped classroom factors. Specifically, we consider course's learning objectives, course structure, and learning outcomes to evaluate of flipped classroom activities shown in Table I and Table II. Finally, we then rank each factor based on the advantage and disadvantages of specific class design. Figure 1 shows the framework of this systematic approach.

B. Design flipped classrooms and effectiveness evaluation

Through the systematic approach, we can identify the influential factors for designing flipped classrooms for data management courses. In this research, we take our two courses as an example to investigate the implementation of the influential factors in data management courses. The selected courses are CIT 21400 – data management and CIT 44400 – advanced database design courses, which are courses for sophomore and senior students, respectively. In the process of implementing the flipped classroom activities, we not only considered the learning outcomes, course topics but also considered different sub-topics. Since a particular topic of a specific course associate with certain learning outcomes, we believe the different flipped classroom activities should be implemented even for different topics of a course. Given that the flipped classroom activities designed for each class are highly associated with course topics, we first categorize course topics into broader categories, then design flipped classroom models for each category. After analyzing CIT 21400 course contents and learning objectives, we categorize CIT 21400 topics and CIT 44400 topics into 5 categories respectively as shown in Table III and Table IV.

TABLE III
CIT 21400 TOPIC CATEGORIZATION

Category	Topics
Logical database design	Database Normalization, etc.
Information seeking	SQL query writing, etc.
Mathematical thinking	SQL operators such as union, etc
Apply database concepts	DBMS functions, administration, etc
Correlate to real-life scenarios	DBMS approaches, etc

TABLE IV
CIT 44400 TOPIC CATEGORIZATION

Category	Topics
Logical database design	Requirement analysis, etc
Information seeking	Search for a hotel rating, etc
Mathematical thinking	Computing hotel rating, etc
Apply database concepts	Importing data, etc
Correlate to real-life scenarios	Implementing a prototype, etc

To make these categories also match the view of our students, we conducted surveys in Fall 2019 for control courses (without flipped classroom setting) for both CIT 21400 and CIT 44400. In these surveys, we asked students to categorize various topics they learned into the categories mentioned in the Table III and IV. The survey result shows that about 89% of the categories selected by students' match our categorization. The mismatched one is consolidated through consultation with other lecturers in our department.

The categorization of the course topics drives the arrangement of various course content for each topic. We plan to utilize a methodical subject-didactic choice approach for content selection. We realize that content selection must fulfill our students' learning objectives. Once the appropriate con-

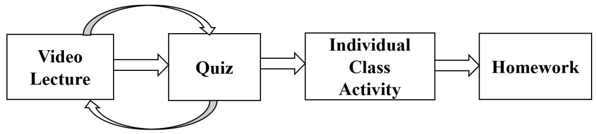

Fig. 2. Flipped Classroom design for the topic "Normalization" of CIT 21400

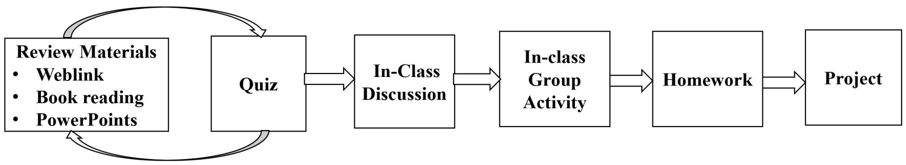

Fig. 3. Flipped Classroom design for the topic "Database Cursors" for CIT 44400

tent is selected for each topic, the activities can be shaped accordingly. We plan to design and create different types of pre-class and in-class activities to meet a particular learning objective for each specific topic of the sophomore and senior courses. We also make sure the pre, in, and post-class activities are appropriately aligned. For example, for CIT 21400, which is an introductory course with the learning outcome of understanding and applying knowledge to "logical database design," we use video lectures as pre-class work. Meanwhile, we use the 'Quick Check quiz' to motivate students to watch the video. As an in-class activity, we give students problem-solving tasks with follow-up homework to test whether they can apply the knowledge to a similar problem.

On the other hand, CIT 44400 which is a senior course with the learning outcome of the analysis and critical thinking on how to "apply database concepts to a problem", we require our students to study a project implemented by a public organization and accessible by us, such as SourceForge. As an in-class activity, we organize students in groups to evaluate the project in terms of design, scalability, and other data management perspective. As a follow-up assignment, we assign students a task to improve the project. In the end, as a formative assessment, students are expected to use the knowledge in their homework and project.

Figure 2 and 3 provides examples of implementation of different pre-class and in-class activities for different topics. The "Normalization" is a topic for CIT 21400, which is an introductory database course, we design a flipped classroom model that could utilize the flipped classroom designed demonstrated in Figure 2. In this design, students need to watch pre-recorded video lectures on the topic, followed by a low stake knowledge check quiz. Students could be able to take this quiz multiple times. As a class activity, students get individual tasks on the topic. In the end, as part of the formative assessment, students need to accomplish relevant homework. On the other, the "Database Cursors" is a topic for CIT 44400 which is a senior database implementation course, we design a flipped classroom model that utilizes the flipped classroom activities demonstrated in Figure 3. In this design, students need to review the topic "Database Cursor" which they learned in a pre-requisite course CIT 30400 Database Programming or gather information from various resources followed by a low stake knowledge check quiz. Students could be able to take this quiz multiple times. As a class activity, students will have discussion and group activity regarding the application of this "Database Cursors" topic.

C. *Overall Framework*

Figure 4 demonstrates the overall framework from identifying influential flipped classroom factors to the implementation of the factors. The whole process starts with a systematic literature review on factors for flipped classroom design and implementation for STEM. Then, an analysis is done on each factor for the specific data management courses where the flipped classroom factors to be implemented. The selected factors are implemented in the two courses in this research. This process can be iterative until satisfactory evaluation results are achieved. To evaluate the effectiveness of different factors for different categories, both formative and summative assessments, such as students' performance data, interviews, and surveys, can be conducted. Evaluations should be employed on the control courses and the courses with flipped classroom implementation.

This work can help to design the baseline flipped classroom model for the data management and data science domain, including the data management courses in our Computer Information Technology (CIT) department. This process can also help us to identify whether we need different flipped classroom design for sophomore and senior-level classes.

IV. Results and Discussion

The objective of this work is to find the most influential factors for flipped classrooms for the data management courses in our CIT department. To evaluate the effectiveness of each factor, we plan to not only analyze students' performance data but also analyze the students' opinions (positive or negative) collected regarding the usefulness (or effectiveness) of each factor towards their learning near the end of the semester through surveys and focus groups. Qualitative analysis of the lived experiences of students completing data management

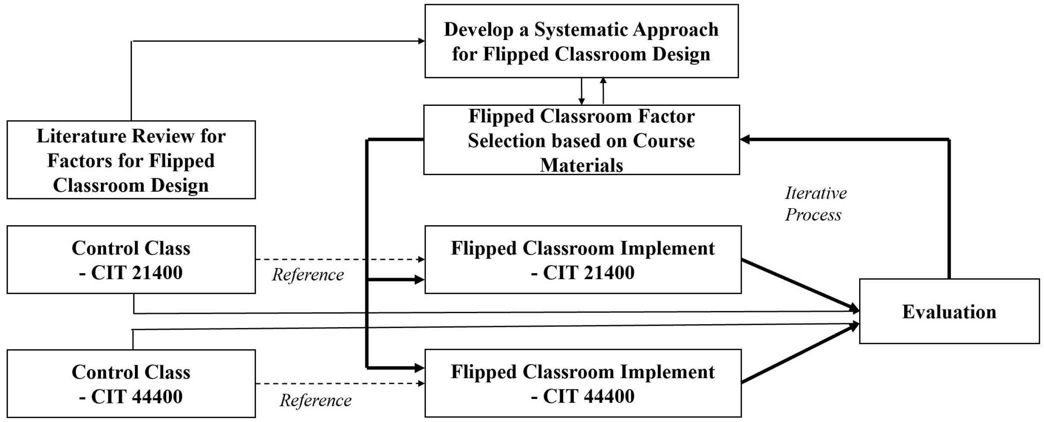

Fig. 4. Overview of the project components and workflow

tasks can be done. Also, we plan to explore a phenomenon through the lens of the participant via post-activity interviews [21], [22]. Other than applying the basic statistic summary as the quantitative analysis on the interview results, the ANCOVA analysis [23] is to be employed to understand the development of students' self-reported skills on data management tasks.

The control courses (without flipped classroom setting) for both CIT 21400 and CIT 44400 have been implemented in Fall 2019. The intervention courses (with flipped classroom setting) are to be implemented in Fall 2020. In Fall 2019, we conducted two anonymous surveys to the controlled groups, namely CIT 21400 and CIT 44400 lectured-based sections. For CIT 21400 survey, 23 students participated, and in CIT 44400 surveys, 15 students participated. In these surveys, we collected data on students' opinions on "How do they feel they are doing in the course, in general?" Approximately 16% percent of students in CIT 21400 and 11% of students in CIT 44400 think they are not doing well. We also collected data on "What was the most difficult part of succeeding in the course and whether they have any suggestions for their instructor to address that issue." In CIT 21400 course, several students expressed the need for a practical demonstration. The comments from students include "More demonstrations of doing the assignments and explaining how to think of going about it". Besides, approximately 30% of students thought video lectures would be helpful, and approximately 47% of students suggest in-class activity should be helpful to lead the course to be more successful. In these surveys, we also collected data from students on the types of pre or in-class activity they thought might be helpful to learn a specific topic of a category. Figure 5 and Figure 6 show the top activities students suggested for CIT 21400 and CIT 44400, respectively. We plan to utilize these data when we implement the flipped classrooms in Fall 2020.

By the end of the semester of Fall 2020, we plan to compare control courses (traditional lecture-based courses) and the courses with flipped classroom implementation. The comparison needs to be done in terms of students' success and experience. For students' success, we plan to analyze students'

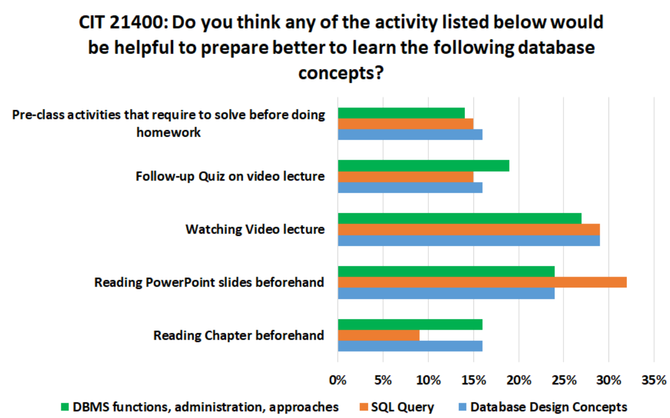

Fig. 5. Recommended Activities for CIT 21400

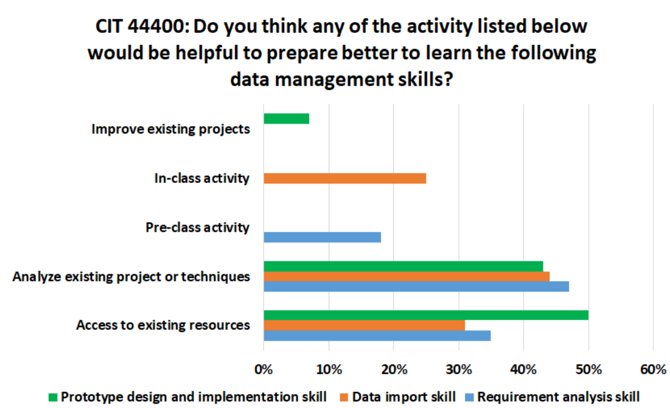

Fig. 6. Recommended Activities for CIT 44400

course performance data, including the students' grades and assignments. Surveys are expected to be sent near the end of the semesters to collect students' perspectives regarding instructional methods. The surveys for the intervention courses which implement the flipped classroom models and activities, students' opinions (positive or negative) are to be collected regarding the usefulness (or effectiveness) of each factor (pre-class activity, in-class activity, group work) to learn a specific data management skill. In Fall 2020, we plan to collect mid-semester feedback from students using a survey to adjust pedagogical methods. Based on the previous enrollment number for both courses, we expect to have 50 students in total for these surveys. The research interactions are to be included focus group interviews in later 2020 to collect information regarding changes in the instructional model.

V. Conclusion and Future Work

In this work, we develop a systematic approach that can be used to identify influential factors for designing and evaluating the flipped classroom model for a data management or data science course based on the course objective, learning outcomes and schedules. The success of this project can lead to substantial curriculum changes in the data concentration in our CIT department. This flipped learning model can be used as a baseline to teach other data management or data science courses in our CIT department. The proposed project is consistent with the current national need for advancing STEM education to prepare a more robust technical workforce. The success of this project can directly benefit society by improving education in the STEM disciplines. The proposed approach can be applied to any courses within STEM and outside of STEM. Furthermore, the collected data through the project can be used to understand whether this efficient flipped classroom can be used to improve the underrepresented students' performance in STEM study.

The future work of this project includes developing a tool that can automate the systematic approach to analyze whether a flipped classroom model can be designed for a course. The automated system takes a defined list of factors for flipped classroom design, as well as the course materials. Then, it analyzes the course objectives, structure, and outcomes. The output of the system is selected factors and implementation design for the course. The automated system will be created based on the course materials and the flipped classroom design factors that we discover through the literature review process. Computing science techniques, such as text mining [24], concept extraction [25] [15] and concept embeddings [21], [26] can be used to create this automated process.

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