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Grounded Theory Investigation into Cognitive Outcomes with Project-Based Learning

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Abstract

There is increasing use of business analytics (BA) systems in industry to support decision making and process improvement. BA systems provide specialized functions for data collection, cleaning, analysis, query, and reporting. The need for BA skills in the workplace is driving the growth of graduate and undergraduate programs. However, such curriculum presents pedagogical challenges due to the interdisciplinary nature of enterprise BA work and the demand for a broader range of skills by the industry. BA courses need to go beyond emphasizing tool procedural skills and quantitative statistical knowledge. Project based learning (PBL) refers to pedagogy that engages students in educational content that is based on standards and practical business use cases and supports building higher level competencies such as problem solving, critical thinking, collaboration, communication, and innovation. Incorporating PBL in a BA course allows students to experience real world BA projects by working with business end-users. This study collects interview data from the students and participating business users and explores how PBL leverages real-world situational conditions, and group interactions to increase higher level cognitive learning outcomes. The research uses grounded theory to identify relationships among PBL, and group and individual factors on cognitive outcomes.

Keywords: Cognitive outcomes, enterprise business analytics, project-based learning, grounded theory.

1. INTRODUCTION

Organizations are collecting large amounts of data in enterprise applications and then deploying business analytics (BA) systems to utilize these data sets to improve their cross-functional business processes (Elbashir, Collier and Davern, 2008). Enterprise business analytics refers to the use of BA tools that leverage enterprise systems to create and deploy models that span multiple functions (Davenport and Harris, 2007). This is accomplished by utilizing BA applications that can aggregate cross functional datasets extracted from systems such as ERP to create new organization wide capabilities. As opposed to departmental or function-based analytics applications, enterprise analytics has several advantages, such as broad impact across the organization and the ability to yield "one version of the truth" information. The growing adoption of enterprise analytics is also creating an increasing need for BA skills in the workplace and driving the growth of graduate and undergraduate coursework and educational programs at universities (Mills, Chudoba, and Olsen 2016). However, the curriculum of such programs presents pedagogical challenges due to the demand for a broader range of skills by industry (Radovilsky and Hedge, 2022). Paul and MacDonald (2020) compiled and classified a list of six groups of skills that include business knowledge, technical coding and programming, data modeling, and problem solving, in addition to typical quantitative knowledge like data mining and statistical methods. A Delphi study and survey with an industry panel by Cegielski and Jones-Farmer (2016), along with job content analysis revealed that a business education,

together with problem solving and communications skills were in greater demand by industry than mere quantitative knowledge. Yet the primary focus of many current BA educational programs continues to be the coverage of quantitative skills and building BA tool procedural knowledge. Current BA pedagogy remains mostly "hands-on" skill-based, highly procedural, and narrow in scope, and does not allow the typical student to grasp the tight data integration among business functions and the inter-disciplinary nature of BA jobs in industry. This is resulting in a mismatch ("gaps") of skills generated by educational institutions and skills demanded by employers. To resolve these skills gaps, Markov, Braaganza, Taska, Miller and Hughes (2017). recommends the creation of new learning pathways and programs that concentrate on emphasizing business domain knowledge, BA industry practices and processes such as CRISP-DM, and managerial and communications skills.

Radovilsky and Hedge (2022) documents a wide diversity in course content and pedagogy in BA educational programs and finds no consistency in the coverage of the four sets of skills – technical, analytical, business and communications. Their analysis of 121 course syllabi, which was taught over four academic years from 2016 to 2020, shows limited consistency in the courses with regard to pedagogy and content covered. Courses in business analytics continue to emphasize quantitative theory and quantitative methodologies and BA tool procedural skills. However, the feedback from industry suggests that only learning the mechanics of a BA tool in conjunction with quantitative statistical methods is insufficient for students preparing for enterprise BA jobs. It is imperative for educators to expand their approach and integrate these theoretical curricula with project-based assignments to broaden student learning outcomes, particularly higher-level, "real-world" cognitive outcomes such as judgment, critical analysis, confidence and application of BA systems to practical scenarios. Yap and Drye (2018) describes the successful application of practice-oriented projects to introduce theoretical BA content to students in a practical way. Their approach emphasizes the use of real-world data sets and application of relevant technology and methodology to create useable products for end users.

Project based learning (PBL) is a pedagogical approach that successfully blends the formal and informal phases of learning new skills and emphasizes the casual transfer of knowledge among group members (Marcris, 2011; Leidner and Jarvenpaa, 1995). Gupta, Bostrom and Huber (2010) found four categories of pedagogical factors that impact learning outcomes: (i) technology characteristics, (ii) individual motivation, (iii) social influence, and (iv) situational constraints. Each of these are sufficiently represented in group project-based learning programs. Educational outcomes depend on the pedagogy used and the shared insight of the participating students and faculty, who are the stakeholders of the BA curriculum (Bose, 2009). PBL participants learn from each other as well as from the course content by executing the educational program in a practical setting, solving real world projects. Such group based educational programs are also more supportive of the cognitive outcomes necessary for individuals to become successful industry practitioners of BA systems.

Gupta, Bostrom and Huber (2010) also reported the difficulty to assess "real-world" cognitive outcomes during the learning period with existing assessment models, as such measures rely on future job performance. Published BA pedagogy research also does not report any suitable measurement models to make cognitive outcome assessments during the educational program. However, the authenticity of the learning environment created by PBL, which demands students execute genuine workplace tasks, supports the development of a measurement framework to allow self-assessment of learning outcomes, including cognitive outcomes, during the learning process.

Research Goals

The focus of this research is to study the impact of group project-based learning (PBL) on the cognitive outcomes of students of BA courses. PBL programs allow students to work in groups to learn and apply the theoretical concepts collectively with real world business end users. The project activities are supported with genuine real life project scenarios along with interactions with these business users. This study aims to contribute to the body of knowledge by researching an innovate project based learning program and proposing an assessment model to measure the effect of the PBL program on the cognitive outcomes of the participants.

2. GROUNDED THEORY

This study uses qualitative research with interpretative methods based on semi-structured interviews. Interpretive research is inductive and does not rely on previous literature or prior empirical evidence (Eisenhardt, 1989, Strauss

and Corbin, 1990). The objective of grounded theory is to generate constructs and discover relationships among the constructs using qualitative data. Rather than start with a pre-conceived research model and hypotheses to test, grounded theory uses an inductive approach, which is data driven, and through simultaneous data collection and analysis to discover patterns and concepts underlying the phenomena. This methodology places emphasis on abstracting participants' accounts of experiences and events and relating those to existing literature to explain the phenomena (Strauss and Corbin, 1990, Suddaby, 2006). In this approach data is analyzed by comparing incidents and connecting emerging concepts in concert with theoretical research. This recursive activity employs theoretical sampling whereby additional data collection builds around the occurring findings and narrowing the scope of the study until theoretical saturation is reached where no new data changes the emergent constructs. Moreover, this type of methodology explains process, `how' research questions, and context, and provides detailed information for deducing constructs for theory generation and elaboration.

Proposed PBL Pedagogy

The essential elements of the proposed PBL pedagogy are: (1) including significant content that is relevant and derived from standards and concepts at the heart of practical business use cases, (2) building higher-level competencies such as problem solving, critical thinking, collaboration, communication, and creativity/innovation and (3) engaging the students in an extended, rigorous process of asking questions, using resources, and developing answers. These characteristics of PBL are supported by providing open-ended project scenario(s) that students understand and find intriguing. These scenarios generate interest and curiosity among the students and produce a need to gain knowledge, understand concepts, and apply skills to create outcomes that are applicable to their jobs. Mimicking the real work environment is critical and is achieved by allowing the students to make choices about the BA information products to be created for their assigned course project. The PBL project allows them to give and receive feedback on the quality of their work, leading them to make revisions and motivating further inquiry.

The Project Based Learning (PBL) pedagogy used in this study also incorporates several learning elements, including: (1) the use of "messy" datasets, (2) interactions with actual client business users to allow the students to build systems to target these real organizational users, and (3) an iterative approach for the project development using periodic reviews with the business users. The PBL program was adopted inside a senior experience business analytics course for undergraduate IS majors.

	PBL Topics	**Practical Group Work**
1	Read/Analyze a BA project Case Study to discern the nuances of a "industrial" sized BA project.	Analyze/Discuss Case Study to identify the project stakeholders, phases, challenges faced, and strategies. Enumerate project activities and efforts needed in phases of a typical BA Project
2	CRISP-DM Methodology Data Visualization	Use Visualization Tool on a real-world data set to discover and understand data relationships.
3	Business Use Case & Systems Requirement Analysis; Scope definition of assigned project	Collect and analyze the project requirements and use cases from business user – create wireframe prototype of the application user interface
4	Learn Key Performance Indicators (KPI) Information data Lifecycle and Data Quality	BA Tool feature selection and learning (tool procedural) Identify cross functional KPI's for the end user use cases
5	Data Modelling Data prep and model creation	Build logic-based data model to support the end user reequipments and use cases collected
6	Data mgmt. and storage tools (ETL); Predictive Analytics & Data Relationship	Identify Input data and sources Data Storage Design Build and test prelim project & user reviews
7	BA project feasibility analysis; Unstructured data analysis	Add "what-if analysis" to BA project Feasibility Analysis, Build, test, deploy final project with Users
8	Project Reports, Presentations, Documentation	Project/User doc and Project Presentations, Project Retrospective

Table 1: PBL Weekly Topics & Assignments

The PBL program was administered as a practical summative term project assignment over the

second 8 weeks of a 16-week semester. The detailed schedule of the PBL learning topics and group assignment is listed in Table 1.

The 8-week PBL assignment was embedded in a semester long face-to-face BA course with weekly lectures on theory and in class and outside class assignments with a leading ERP vendor's BA tools. The theory was delivered with lectures on various topics such as business analytics models and case studies, requirement gathering and documentation, dashboard design, data modelling data management, and project management. There were 11 students in the course, and they were provided 2.5 hours/week of instruction about analytics methods, principles, and case studies as part of the theoretical portion of the course. Students were divided into groups of 3 and given access to a BA industry consultant and business end users. PBL required the students interact with real business users to define the actual project assignment in detail, including user scenarios. A large data set was extracted from the client company's ERP system and provided to the students to work with. The data set contained financial, production, materials, human resources, and operational maintenance, training, and safety data. The students were required to learn and use the CRISP-DM (www.crisp-dm.eu) methodology to define and implement a business analytics project that the business end users would use.

3. DATA COLLECTION AND ANALYSIS

The 11 students were divided into four small groups (3 members in each, except one with 2 members) and each assigned to a business end user. Their first objective was to thoroughly understand, from a business perspective, what their assigned business end user really wanted to accomplish with the BA project. The participants documented the business use cases and made decisions on how to utilize the data set to support the KPI's deemed necessary by the business user. The groups then designed and built BA dashboards that displayed the functional variables and relationships (in the data). They designed quantitative KPI models to add "what-if" scenarios with the BA tools. Contacts in the client company and the BA consultant were available during the entire 8-week duration to answer questions and review project scope and designs.

As the objective of this research is to generate theory, which explains how higher-level cognitive outcomes are enhanced with PBL, a total of 16 interviews were conducted with multiple stakeholders after the 8th week of the PBL learning pedagogy (Table 2). A pilot interview was conducted with one of the business users and a student, followed by 3 subsequent stages of interviews. In all, eleven students, 4 business users and one IT industry consultant, were interviewed over four weeks. Concurrently, the relevant published literature was searched and analyzed. The generalizability of the findings of a qualitative study are strengthened by including more than one participant's perspective and incorporating theoretical perspectives at multiple levels of analysis into the discussion. A grounded theory model of measuring the impact of PBL on cognitive learning outcomes is a product of this research study. Although the interviews were open-ended, the following questions guided the theory building:

1. What types of challenges did you face in performing the project methodology including requirements analysis?
2. What knowledge needed to be shared to define the BA system with the business end-users (students)?
3. How were the project activities facilitated by group members and knowledge shared between students and business users?
4. What were the educational benefits and drawbacks of incorporating a practical project with "messy" data and interactions with real business users?

Interviewee's role	Number of interviews	Hours
Undergraduate Student of IS	11	5.5
Business User	4	4.0
BA Industry Consultant	1	1.0

Table 2. Interviewees' roles and numbers

Data Analysis

The interview scripts were coded using nVivo software. Each interview was transcribed to a separate document and the documents uploaded into the tool. This tool has a sophisticated search engine and features that enable saving search terms and outputting search results for specific terms. Coding in grounded theory has three stages: open coding, selective coding and theoretical coding. In the open coding phase, the transcripts from the interviews were listed as quotes and analyzed line by line to identify concepts. The key concepts emerged from open coding, and a technique was used for categorizing interview data allowing the major concepts to be

identified along with their properties (Table 3). Subsequent theoretical coding was used to relate concepts to other concepts, establishing a model of the perceived phenomena. Analysis continued until no further concepts emerged - the point at which theoretical saturation is reached.

4. RESULTS

The grounded theory approach culminated in a model that sheds light on a fresh theoretical perspective of enhancing the higher-level cognitive outcomes in a BA course with PBL pedagogy (Figure 1). The theoretical model relates the four concepts found from coding the interview data: PBL, cognitive outcomes (CO), individual factors (IF) and group interactions (GI) and is illustrated in Figure 1.

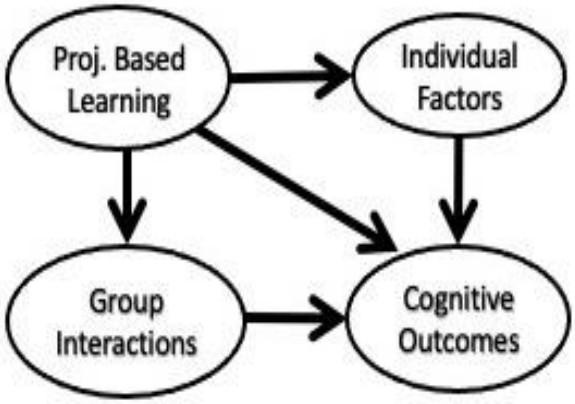

Figure 1: Grounded Theory Model

Project Based Learning (PBL)

The collaborative PBL projects are designed to require students to work in groups and learn the practical use of BA tools and methods by participating in genuine real-world experiences. Compeau, et.al. (1995) proposed a framework of key factors in the management of BA courses that highlights different phases of a BA project such as initiation, formal, informal, and continued learning and addresses the issue of transfer of learning to the workplace. The course structures together with the content impact the learning outcomes of the participants. PBL participants learn from each other as well as from the program content (Marcris, 2011; Leidner and Jarvenpaa, 1995) and execute the learning tasks in a genuine real world setting. PBL based pedagogy emphasizes these phases of learning and the casual transfer of knowledge among group members. Some of the beneficial use of PBL are identified by the business end users in interviews:

(1) *"Current business analytics work is complicated as it crosses several knowledge areas, and it is critical that students learn and use the standard methodology before they come to the workplace."*

IT tools to support group project-based learning includes collaboration systems (Microsoft Teams), descriptive content (lecture notes) and document management systems (Google Docs). Student engagement is also achieved with the help of discussion boards in the Canvas course management systems to allow rapid, real-time flow of information in response to student questions (Ghosh, Yoon &, Fustos, 2013). Students mentioned the benefits of the group projects:

(2) *"The project details were left up to the group and required working with the end users."*

(3) *"Group work was very helpful. We used Microsoft Teams to share with each other"*

The students learn from the knowledge of other group members, who come from different educational pathways to understand cross functional KPI's and build a logic driven BA model, using enterprise level data sets, that can be used to measure these KPI's. Such learning content also fosters joint work, the need for business problem solving and reflection and sharing of insights among the group members (Ryan and Deci, 2000). The BA Consultant says:

(4) *"They understand how real analytics projects are done. Students get job ready."*

There is considerable evidence to suggest that this peer support is also important to improve learning and course outcomes (Worrell, Gallagher & Mason, 2006; Volkoff, Elmes & Strong, 2004). Other students mentioned project characteristics such as: "*Needed more definition"* and the "*open nature of the project scope*" of what to accomplish made the project "*interesting and challenging*."

PBL based pedagogy fosters the long-term success of educational programs in BA systems. Student quotes say:

(5) "*Most difficult part was dealing with the messy data and the project was frustrating at first, then we figured it out over time."*

(6) *"Working with a business user was difficult to coordinate and fully understand what they were asking for and why."*

(7) *"Working with real data and business users allowed me to learn ways of data collection, cleaning, aggregating and refreshing and then operationalizing analytics algorithms."*

Cognitive Outcomes (CO)

The three categories of learning outcomes are: (1) procedural goals such as the ability to use BA tools, (2) cognitive goals that focus on solving real business problems and (3) meta-cognitive goals that focus on the student's belief regarding their own abilities with the content (Gupta, et.al, 2010). A quote from the BA consultant notes,

(8) *"We have to do a better job to prepare students for work, where they work with incomplete pieces of information and be able to flush out the details in iterations".*

Cognitive learning outcomes (CO) include the mental awareness and judgments of the students and their ability to transfer their learning to new situations, such as applying the software application to solve a new problem different from what was used in the course project. Finally, meta- cognitive goals focus on enhancing the learner's ability to understand his/her own learning and information processing capabilities and confidence (Gupta, Bostrom and Huber, 2010). Business users quote says,

(9) *"It is crucial that the students get work experience during their college years. That is the only way they can succeed on the job after their degree".*

Higher level cognitive outcomes also include the growth of self-confidence to allow the transfer of the learning to new situations that require understanding the interactions of multiple parts of a complex scenario. When cognitive outcomes are emphasized in the learning program, the participants build the capability to apply their learning in real-world scenarios (Gupta, Bostrom and Huber, 2010). They grasp the path to apply the acquired knowledge of BA tools and methods, such as appropriate KPI's selection and implementation from organizational data. A student quote says:

(10) "*We could understand, from a business perspective, what the user really wanted to measure and accomplish from our project."*

This pedagogical approach also holds promise to address the difficulties of grasping the nuances of "real-world" BA methods without adversely impacting broader educational standards (Chang and Chou, 2011). Cognitive outcomes also include the growth of self-confidence to allow the transfer of the learning to new situations that require understanding the interactions of multiple parts of a complex scenario. To mimic real-world problems, which are typically ill-structured, the assigned PBL projects are loosely defined initially to require the groups to collaborate extensively to characterize the project scope. Student quotes say:

(11) *"Defining the project scope was important to be able to finish the work."*

The students proceed to identify diverse sources of data from different functional areas and design and create BA information products that span multiple business processes. Student interviews mention:

(12) *"We had so many questions that not all of them got answered."*

The learning outcomes for PBL is supported by four different sets of determinants: technology, individual difference, social influence, and situational constraints. PBL builds engagement among the students through trust (Gefen, 2002) and social integration during the learning process (Elbanna, 2003) and drives collaboration and knowledge sharing in the group. They share and combine their individual learning to support building a "big picture" and establishing their own collective group discourse (Wang and Ramiller, 2009). A student quote says:

(13) *"We had to make decisions and keep working on the project. Every week there were new items to work on and this rapid, flow of information in response to our questions helped guide our work."*

Individual Factors (IF)

Individual factors include "mental states" and "learning traits". While "mental states" are general influences on performance that vary over time and include temporal factors such as motivation level and interest level, "traits" (such as preferred learning style are static aspects of individual factors, that affect a broad range of outcomes over time (Bostrom, Olfman and Sein, 1990). These factors play a role in how the PBL program can impact each students' learning

process and outcome (Gupta, Bostrom and Huber, 2010). A student quote says:

(14) "*I had to work harder in some weeks to meet the deadlines with the business users. I did not want to be the slacking group member.*"

Motivation to learn refers to the desire of an individual to learn knowledge and/or skills (adapted from Noe, 1986). Motivation to learn has been extensively studied in training literature and shown to be a key determinant of choices individuals make to engage in, attend to, and/or persist in learning activities (e.g., Klein et al., 2006; Facteau et al., 1995; Noe and Schmitt, 1986). Motivation theory explains individuals' learning behaviors (Van Der Heijden, 2004; Tharenou, 2001) and suggests that individual behavior is determined by two fundamental types of motivation: extrinsic (utilitarian) motivation and intrinsic (hedonistic) motivation (Alavi, Wheeler, and Valacich, 1995). As a student interview says:

(15) "It was good to work on a practical project that may benefit business people."

This suggests that motivation to learn can influence an individual's behavior (e.g., Kontoghiorghes, 2002; Colquitt et al., 2000; Noe, 1986). Compelling messages received from group members in support of the application of BA are also likely to influence individual factors about the expected outcomes of the curriculum. A student quote says:

(16) "*My group helped me understand better.*"

The level of interaction within the project group facilitates individual engagement with the learning program. In group-based learning, team members work together and influence each other's motivation by voicing demands for contributions. Group projects require individuals to cooperate and work together but have significant learning benefits of efficiency and productivity (Baskin, Barker and Woods, 2005). As a student says:

(17) "I had to stay on schedule to work successfully with my group members."

Motivation is influenced by various factors, such as peer support (Facteau et al., 1995; Baldwin & Ford, 1988), and situational constraints (e.g., lack of time or resources) (Klein et al., 2006). In addition, motivation to learn is influenced by individual characteristics such as self-efficacy (Al-Eisa et al., 2009; Colquitt et al., 2000) and perceived benefits (Noe & Wilk, 1993). The motivation literature suggests that motivation can impel action and act as an inducement to action. According to Locke and Latham (2004), motivation can affect three aspects of action: direction (choice), intensity (effort), and duration (persistence). An business user quote says:

(18) "*The students were interested to learn about our business and address our needs.*"

In addition, training literature suggests that motivation to learn can influence behavioral intention (e.g., Tharenou, 2001; Noe & Wilk, 1993). For example, according to Al-Eisa et al. (2009), motivation to learn was found to influence learning skill transfer intention, which refers to a commitment to apply newly acquired knowledge or skills to the work setting. A student quote says:

(19) "*My interest about business analytics jobs grew from doing this course.*"

Group Interactions (GI)

Group interactions comprise factors such as if team members shared diverse viewpoints and if such interactions were valued as well as the nature of cooperation and the level of dialog achieved within the team. Project based learning (PBL) that uses authentic, complex scenarios creates an impetus for group dialog to apply that knowledge to solve the problem assigned (Uribe, Klein and Sullivan, 2003).

Shared cognition theory focuses on individual learning within a social situation, allowing for social interactions that support the individual's cognitive development with help from more capable group members. Based on shared cognition theory, project-based learning (PBL) allows participants to engage in learning activities by working in groups to investigate and respond to a complex question, problem, or challenge (Marcris, 2011; Alavi, Wheeler and Valacich, 1995; Leidner and Jarvenpaa, 1995). A business user quote says:

(20) "Our dialog with the students was beneficial to all of us. They got some work experience and we got new ideas."

The level of interaction within the project group facilitates individual engagement with the learning program. In group-based learning, team members work together and influence each

other's motivation by voicing demands for contributions. A student quote says:

(21) "*We supported each other in our group as the project was challenging and was it was necessary to divide up the work."*

PBL supports collaborative group learning and the sharing of knowledge among team members. The PBL group creates, and shares goals and learns together by working jointly and solving the problems posed by the project. The group interactions play a critical role in the learning environment through the size and heterogeneity of the team. Group interactions impact learning outcomes by developing diverse knowledge and building broader perspectives that span business functions (Seethamraju, 2008). As a student says:

(22) *"Group members were helpful to understand the project tasks as well as how to do the project."*

Students of BA must grasp and integrate cross-disciplinary knowledge so they can communicate and work cooperatively with others (Wang and Ramiller, 2009). Based on situated learning theory, effective group learning programs must require that group members reflect upon their learning and contribute their experiences, observations, and insights back into the group's collective discourse in a group-based collaborative setting (Wang and Ramiller, 2009). As important referents communicate in the PBL setting, an individual may incorporate the opinions of peers as a part of her own belief structure (Fulk 1993; Lewis, Agarwal and Sambamurthy, 2003). As a student says:

(23) *"I liked the ideas shared by my group members as I never thought of them before."*

Group theories suggest that many factors can influence the outcomes of group-based learning (Sharda, Romano, Lucca, Weiser, Scheets, Chung and Sleezer, 2004). This includes group characteristics, such as composition (level of homogeneity and heterogeneity), amount of group cooperation and the nature of group communications. Group influence has been found to emanate from a variety of sources (Lewis, Agarwal and Sambamurthy, 2003). Each participant brings their own experience and expertise to share their knowledge with the group. There is a constant interaction and collaboration among participants that allows everyone to develop more improved skills in solving problems, than if they worked alone (Sharda, et.al., 2004). The joint experience allows each participant to explore the project from other user's perspectives and helps them to bridge "gaps" in understanding, create new meanings and explanations through shared understanding and practical use to perform specific tasks (Chang and Chou, 2011).

	Property	Quote
PBL	Cross functional, group problem solving approach	23
	Interactions with real world business users and "messy" data	2
	"Fuzzy" details to be worked out using iterative methodology	11
CO	Mastery of BA methodology and industry practices	19
	Self-confidence to execute BA project (beyond Tech credentials)	10
	Demonstration of BA project skills thru adaptability and application	1
IF	Motivation- intrinsic	14
	Motivation- extrinsic	15
	Learning style	Bostrom ,et.al. (1990)
GI	Support and Teamwork	3
	Knowledge Sharing and Cognition	22

Table 3. Concept Development and Coding

4. CONCLUSIONS

Business analytics (BA) courses are growing in university curricula as students seek to build BA skills and knowledge in response to employment demand from industry. Commercial organizations are increasingly adopting BA systems to facilitate data driven decision making by allowing easier data manipulation, visualization, and processing. However, the complexity and diversity of BA systems and their inter-disciplinary nature make their pedagogy difficult at the curriculum level. Many institutions find that emphasizing quantitative knowledge and building BA tool procedural skills fall short of what is demanded by industry. Authentic real-world project-based learning (PBL) requires that students work with "messy" data with incompatibilities, select and apply complicated algorithms to process the data and the engage with actual business users to learn to manage their involvement with project tasks while learning to use the BA methodologies and tools. Data pre-processing is often not

covered in traditional BA courses but is a key learning outcome of the PBL pedagogy in a BA courses. The use of practical projects with real world business end users allowed students to better understand these aspects of practical BA systems.

The study develops an innovate project based learning (PBL) program for BA courses and proposes a model based on grounded theory. The PBL program allows participants to learn the concepts of BA collectively and is supported by a market leading vendor's BA tool. The unique features of the program are (1) use of actual real world client data and (2) availability of client business users to allow the participants to collect analytics business requirements, (3) the educational diversity of PBL group members and (4) the iterative approach to the project development using periodic reviews. The study found that PBL is a viable pedagogical approach to support higher cognitive outcomes of BA courses. PBL increases interactions among students working in project groups that provide a higher cognitive level of learning. The interactions of the students with the business end users were essential for the reliability of the dashboards and reports and their use for decision making.

This study meets the criteria of applicability in grounded theory. It fits the substantive area of study, and it is understandable to the practitioner, and it provides potential control for the action and conditions to which it applies. The results of the study finds evidence to support the notion that project based BA learning programs promote strong group interactions that drive to increase student motivation. The contents of the learning program, such as the use of authentic real-world scenarios, the involvement of external business end users and the diversity in the student backgrounds support building higher cognitive outcomes of the participants.

Implications

This study supports the findings from prior research in the context of BA course curriculum that four categories of individual factors: technology characteristics, motivation, social influence and situational constraints have a critical impact in BA learning outcomes. These factors are all sufficiently represented in the proposed group PBL pedagogy.

Based on interview data collected among students, end user and an industry consultant, this paper finds support for an empirical model that shows a relationship between PBL and cognitive outcomes. Additionally, relationships between group interactions and individual motivation to learn on cognitive outcomes was modelled. The following points follow:

1. BA curriculum must be guided by inter-disciplinary knowledge and skills and go beyond quantitative skills to include real-world experiences to build cognitive outcomes.
2. Business Analytics systems differ from other IS implementations by crossing functional boundaries and do not fit well with many current BA courses in current educational curricula.
3. Learning programs that emphasize practical projects and experimentation can allow participants to have greater motivation to learn and lead to higher levels of cognitive outcomes.
4. The group project-based learning (PBL) approach also supports group interactions that benefit students and the business end users.

5. REFERENCES

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