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TO CLOSE THE SKILLS GAP, TECHNOLOGY AND HIGHER-ORDER THINKING SKILLS MUST GO HAND IN HAND

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ABSTRACT

Technology is rapidly changing the business landscape. Workforce skills gap is widening in the digital business environment. Universities and employers call for developing students' higher-order thinking skills along with integrating technology into academic curricula. We conducted a survey to assess learning outcomes from two groups of undergraduate students: business majors and information technology (IT) majors. SAP ERP hands-on case studies were used for this comparative experiment. The student survey results showed that the students of both majors believed that learning SAP software can lead to more rewarding jobs and they felt confident about their competitiveness in the job market. Although IT majors with stronger technology background have a better understanding of how SAP ERP works with technology than business majors, the findings suggested that both groups of students need to improve their critical thinking, problem-solving and decision-making skills in order to become creative innovators. Differences between academic backgrounds and professional qualifications demand collaboration and professional communication skills at higher education and workplaces. In addition, an alliance between higher education and industry is a promising way to advance education and training for enhancing students' right skills needed in the dynamic business environment.

Keywords: Technology, higher education, digital business, skills gap, critical thinking, problem solving, SAP ERP

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INTRODUCTION

Technology is drastically changing the business landscape in the digital age. For example, with dynamically enabled online shopping, payments and order tracking, businesses can reach national and international customers and realize digital customer communications in real-time. Business can timely adopt most advanced technology by leasing cloud computing services instead of purchasing hardware and on-premise software. Meanwhile, technology is instrumental in providing critical security measures for digital businesseses. Digital business transformation or disruption is referred to businesses as their operation shifts from the traditional operation and management style to the modern and technology oriented ways of operation and management (Brian,2017). Technology innovation is one of the major drivers of digital business transformation. Now, disruptive technologies are not only created at a faster pace but also adopted and used by businesses quickly (Edmead, 2016). Smart device and apps allow business users to collect real-time data and information to perform market research and business analytics at fingertips. On January 28, 2019, Gardner projected worldwide IT spending to reach $3.76 trillion in 2019, an increase of 3.2% from 2018 (Costello, 2019). As the rapid advance of technology is rocking every organization, we must understand that technologies rely on people to be in effect. Therefore, people, not just technology, are key to digital transformation **(**Brown, 2018)**.**

When digitally savvy executives are seeking to align people, processes and culture with the orgnizations' long-term business success, one of the major constraints is lack of talent – skilled workforces *(*Kane et al, 2016). At 2010 G20, the International Labor Organization (ILO) called for a skilled workforce for strong, sustainable and balanced economic growth. The ILO report addresses the productivity at workplaces has a lot to do with the opportunities available for people to acquire and maintain their approprite skill levels. The report calls for all countries, enterprises and people to become aware of skills development as strategic necesity and, therefore, accelarate investment in skills develpment (ILO, 2011). U.S. employers have been concerned more in recent years about what they see as a growing gap between the knowledge, skills and abilities (KSAs) of young people entering the workforce and the KSAs that they believe to be crucial to the success of their enterprises (Labi, 2014).
Robert Kaplan, President of Federal Reserve Bank of Dallas, emphasizes the urgency to build skilled workforce for the digital future, due to the U.S. GDP

growth, the aging baby boomers workforce retirement and the middle-class high-paying jobs increasingly require higher level skills (Kaplan, 2017). Despite all the efforts in the skills workforce development campaign, unfortunately, the skills gap is not closing, but widening faster worldwide. In the increasingly data-driven digital age, there could be as many as 756,000 unfilled jobs in European IT sector by 2020. The emerging technologies could generate at least 133 million new job roles globally by 2022 (Milano, 2019). The emerging technologies are creating new jobs with new skills requirements at a pace faster than ever before. The rapid advance of technolgy makes the global phenomenon of skilled workforce shortage more and more intensified.

In the information era, business leaders are concerned that the younger generation employees tend to research, learn, find solutions and make decisions mainly depending on hand-held devices with search engine (Tulgan, 2018). This learning and thinking behavior of younger generation employees at workplaces is not just caused by absence of work experience, but also caused by lack of critical thinking skills (Tulgan, 2018). To overcome the unfavorable impact of information technology on younger generation, University of Connecticut is one of the institutions in higher education to introduce Bloom's Taxonomy, especially higher-order thinking skills to their students. Critical thinking is one of the main higher-order thinking skills. Bloom's Taxonomy is a classification system for levels of cognitive skills and learning behavior. Based on the degrees of cognitive complexity, Broom's Taxonomy classifies thinking skills into six level: remembering, understanding, applying, analyzing, evaluating and creating. While the first three levels are considered lower-order thinking skill, the next three levels are higher-order thinking skill (cetl.uconn.edu). Serving as university Business and IT professors, it is our responsibility to assess and evaluate the cureent status of our students' skills gap and research ways to minimize the gap. We expect our students to be fully equipped with up-to-date technology, meanwhile, develop critical thinking skills and become active analytical, evaluative, and creative thinkers and innovators. "The U.S. must work to find ways to expand the workforce and improve productivity. One important vehicle for doing this involves policy makers, business and educational institutions working together to create skills-training programs" (Kaplan, 2017).

RESEARCH BACKGROUND

More and more universities join the SAP University Alliance Program (UAP) and adopt SAP materials for their IT, IS and other related curricula. Although there are increasing number of SAP course materials available, SAP ERP usually is the appropriate starting point for SAP curricula.
SAP ERP is the foundation of the business suite (www.sap.com). Enterprise resource planning (ERP) is a large and complex information system that integrates multiple functional business processes with the support of information technology. On January 28, 2019, Gardner predicted that Enterprise software, especially cloud service and applications, would grow faster than any other IT categories. SAP Cloud ERP Suite is one of the top ERP software tools in the world (capterra.com). Having around 200 million users, SAP is one of the world's leading cloud business software providers (www.sap.com). SAP ERP application software is a valuable tool to learn business processes integration.

SAP course content has been integrated into the curricula at both colleges where the authors serve as faculty. This study involves two groups of students in two different universities. Students in one group are in the School of Science and Technology, majoring in Information Technology (IT); whereas the other group of students are business majors, including management, marketing, accounting and computer information systems majors, in the College of Business at another university. The SAP ERP course content using detailed instructive hands-on case studies pedagogy to teach students step by step implementation of business processes integration with SAP technology.

RESEARCH PURPOSE

Although the two groups of students have different academic backgrounds, they work on the same SAP ERP hands-on case studies and exercises along with the same textbook and apply the same revised standard test banks for assessment. The hands-on case studies have very detailed and clear instructional text and screen captures to guide the students step by step carrying out business processes integration, such as procurement, order fulfillment and production. Dealing with business process complexity, any careless mistake in one step may cause obstacles in following steps and most of the time those problems are rather hard to troubleshoot and fix. There is no "undo" like some other application software.

Teaching technology correctly is helpful for students to develop higher-order thinking skills (brighthubeduction.com). The Learning Center at University of North Carolina at Chapel Hill advise and encourage their students to change their study strategies from lower-order thinking levels in high schools to higher-order thinking skills in higher education (learningcenter.unc.edu). Technology should have a positive effect on promoting and improving students thinking and learning behavior.

SAP ERP case study begins with introduction of the enterprise background, followed by the business processes involved in specific business transaction, the trigger of the process, types of data for the process, and the output and outcomes of the process. In order to successfully complete the case study, students must understand relevant business knowledge such as marketing, financial and managerial accounting, etc., familiar with related information technology skills, and know how to combine such knowledge to solve real world problems.

Therefore, it will be interesting to assess if SAP ERP technology integrated curricula help our undergraduate business and IT students develop higher-order thinking skills. Do the students think critically while they step by step follow textual and graphic instructions to implement business processes? Have they learned how processes can be broken down to tasks and steps? Are the students able to generalize the 'point and click' execution experience to how SAP and ERP work? We are aware that the students in each of the two different groups have their unique strengths and weaknesses. We are interested in finding out if the students with different academic backgrounds are satisfied with the SAP integrated course content and feel competitive in the job market.

LITERATURE REVIEW

SAP ERP Integrated Curriculum in Higher Education

For decades, most institutions in higher education have been keeping track of market demand and revising their curricula to accommodate the need for information technology (IT) skills in the dynamic business environment. Adopting SAP software integrated curriculum is a quite common practice in higher education. The recent progress of SAP/ERP hands-on exercises are advanced to SAP S/4 HANA, but there is little research effort about how to improve students higher-order thinking skills when teaching and learning technology, particularly information technology.

Scholtz and Kapeso (2014) identified acceptance and success factor for mobile learning or m-learning to deliver SAP ERP systems curriculum in South Africa. The m-learning system helped the learners save travel expenses and was perceived ease of use and useful. The focus of their paper was on the quality mobile delivery strategy, but not on discussing the motivation and evaluation of adopting SAP ERP curriculum. In 2017, the social and economist studies program at a Czech university was the first one to integrate SAP curriculum in the region. They expected their graduates would have the strongest advantage in the regional job market. After a year's experiment, based on the feedback from their students and faculty, they suggested to minimize the time on learning the relevant theory and maximize the time spending on hands-on exercises (Mesicek, 2018). Part of the rationale was language barrier in English for the Czech students. Diminishing time on learning the theory of business processes integration with information technology and strategies is short-sighted. It's not good for long-term growth of the institution. Ten years earlier, in 2009, Central Michigan University recommended to incorporate SAP ERP technology into higher education curriculum. The hands-on SAP ERP exercises helped their students put business integration theories they learned in classrooms into practice. They demonstrated the higher salaries their graduates with knowledge of SAP ERP got in the competitive job market (McCann and Grey, 2009). When academic programs adopt SAP integrated curriculum, their attention is to let the students get hands-on experience with information technology, which will lead to higher-paying jobs. They often overlook the fundamental purpose of SAP integrated curriculum is to put theory into practice.

Rienzo and Han (2011) conducted an empirical research to assess students' knowledge about business processes (BPs) at multiple time points during the study. In addition, a Technology Acceptance Model (TAM)-based survey was employed to analyze student self-assessment about their understanding of BPs through ERP hands-on exercises. Survey results failed to prove that students' knowledge about BPs was significantly improved after experiencing ERP software. However, students' self-assessment indicated a positive relationship between learning BPs and hands-on experience with ERP software. Iriberri *et a*l. (2015) adopted the technology acceptance model and conducted pre- and post-tests to evaluate the students' perceptions about the SAP hands-on exercises. The data were collected in 2013-2014 semesters from several upper division undergraduate Management Information Systems classes. The analysis of the 230 valid paired samples indicated that respondents had positive perceptions on the usefulness, ease of use, intention to use the ERP system and the training materials. There were significant differences between the pre- and post-tests results regarding: SAP ERP is functional; SAP ERP is useful and easy to use; interaction with SAP ERP is clear and understandable; and SAP ERP tutorials are helpful for understanding how to work with SAP ERP.

Critical Thinking from an Industry Perspective

In spring 2019, Wiley Education Services and Future Workplace surveyed 600 HR leaders about their hiring experience, barriers to identify qualified potential employees with the right skills, and challenges and constraints to implement talent development programs. The 2019 survey results indicate that 64% of the surveyed employers are concerned with skills gap in their companies compared to 52% in the 2018 survey. The skills gap is widening.
The factors contribute to the skills gap include the rapid advance of technology and a tight job market for qualified candidates (Wiley, 2019). On its company website, Deloitte posts an article entitled “Critical thinking rivals technical skills for Industry 4.0 success: Innovative TMT companies value the human factor”. The article identifies 29% among the 612 TMT (Technology, Media and Telecom) respondents to Deloitte’s 2019 Industry 4.0 readiness survey as “high innovators”. Only one third of these high innovators think they have employees with the right skills to work for the digital future. The number one skill that high innovators strive to develop is critical thinking skills (Hupfer, 2019).

Critical Thinking is a Higher Order Thinking Skill

One of the greatest challenges universities facing is the effective use of technology tools to enhance students’ higher-order thinking skills. The abilities and skills within the domain of learning and thinking are classified into six major categories starting from the simplest to the most complex: remember, understand, apply, analyze, evaluate and create. It is generally accepted and understandable that students need to become proficient at each thinking skill level before moving up to the next higher level (Tikhonova and Kudinova, 2015). When universities promote higher-order thinking skills, we assume our students have mastered the lower-order thinking skills: they have developed strategies to remember, understand and apply the knowledge they are taught. When there is abundant ease of access to information online, students are not bothered to remember and understand the available information. Tikhonova and Kudinova (2015) caution university faculty that when shifting their educational paradigm don’t ignore lower-order thinking skills. Lower-order and higher-order thinking skills are interconnected. Lower-order thinking skills are the simple thinking processes that serve as foundations for the complex thinking processes. On the other hand, students must not stop at lower-order thinking skill levels. In higher education, they are expected to transform into higher-order thinkers to close the skills gap at workplace.

The Center for Excellence in Teaching and Learning at University of Connecticut states: “Critical thinking is a higher-order thinking skill.” Higher-order thinking

goes beyond observation and memorization, which are lower-order thinking levels in Bloom's Taxonomy (Celt.uconn.edu). Higher-order thinking skills require judgmental learning, such as critical thinking and problem-solving skills. Higher-order thinking skills are valuable but hard to teach and learn. Critical thinking and problem-solving skills are common, popular measures of learning outcomes and desirable learning goals of curricula in higher education (clearism.com). Then, what are critical thinking and problem-solving skills if we raise the bar to higher-order levels of thinking skills?
Alison Doyle, a job search expert, refers critical thinking as "the ability to analyze information objectively and make a reasoned judgment. It involves the evaluation of sources, such as data, facts, observable phenomena, and research findings" (Doyle, 2019). Osborn, the Father of Brainstorming, presents seven steps for creative problem solving: (1) orientation (2) preparation (3) analysis (4) hypothesis (5) incubation (6) synthesis and (7) verification (Osborn, 1953). Therefore, obtaining timely feedback and appropriately responding to the feedback is also an essential aspect of problem-solving skills.

Ways to developing higher-order thinking skills

There are various processes presented in literature to promote, develop and improve students' higher-order thinking, especially critical thinking skills. There is no quick fix. It takes time to plan and implement. Alkhatib (2019) proposes a learning framework for teaching and implementing higher-order thinking skills in engineering and humanities programs. He outlines activities and coursework assignments designed to stimulate, challenge, and promote critical thinking strategies, expand knowledge base, and develop students' problem-solving and decision-making skills to improve their creativity and innovation abilities.

Wongpinunwatana (2019) presents a model for enhancing students' creative thinking skills through the process of teaching business research. The model postulates while effective logical thinking directly impacts creative thinking via analytical thinking, analytical thinking serves as a mediator between collaboration and creative thinking. Martin (2018) reports a semester long strategic-management class project used to strengthen senior level business students' critical thinking skills. The project is called the Strategic Review, served as a team assignment in a Strategic Management class. Each team selects a company and take a step-by-step approach to develop a well-reasoned recommendation plan for the company's growth and successful future.

Schefer-Wenzl and Miladinovic (2019) present a blended learning course design including pedagogic methods for teaching complex problem solving skills.

The course provides lectures on software integration topics and opportunities for students to apply their complex problem-solving skills to real projects in a domain-specific context.

Rivers and Kinchin (2019) discuss how they developed hidden pedagogy to grow students' critical thinking skills. The pre-test results indicate their students have good lower level thinking skills but have issues to filter information and create new knowledge. They design a weekly 3-hour workshop to develop students' critical thinking skills. The workshop covers the 6 levels of Bloom's Taxonomy from the simplest to the most complex. At each level, the plan is implemented in different format, including lecture, discussion, analyzing and evaluating ideas to create new ideas. The students' activities are organized from teacher-student, individual student, in pairs, in small groups to mixed-small groups. After 12 weeks of regular practices, the students' ability to think is seemingly improved.

Advance Education and Training with Higher Education-Industry Alliance

Traditionally, training is focused on specific skills and short term. Education covers a broad range of knowledge and skill sets, including critical thinking, problem-solving, research, presentation, and so forth. In the knowledge economy, the boundaries between training and education is becoming blurry. In the knowledge economy, education must be more practical, and training must be more advanced (CFA Staff, 2017). In the digital economy, the technology and thinking skills that employees need to be trained in, are of a level higher than ever before and therefore requiring more time to teach and develop. Meanwhile, education can do a better job of recognizing that students need to be able to apply their knowledge if they want to succeed at workplace.

Bohanon (2019) reports a new higher education industry alliance aims to revolutionize outcomes for minority students while addressing workforce needs. A recent survey reveals undergraduate students, especially minority students lack important skillsets in both higher education and industries. The skillsets include critical thinking and problem-solving, collaboration and teamwork, and professional communication (oral and written) skills. The higher education-industry coalition plans to "collaborate to address these barriers, identify best practices, and take action." Many best practice organizations have implemented support programs and accountability measures which can be expanded to higher education. Corporations can also address higher education and student needs such as sponsorship and first-generation mentoring (Bohanon, 2019).

RESEARCH METHOD

Toward the end of the course, we designed and developed a Likert scale survey questionnaire based on the SAP ERP course content and market demand.
The questionnaire consisted of four questions, and each question comprised of three to four sub-questions. The survey was posted online for a week for the students to respond. The two groups of students with their instructors are in two different states and different displines. Our students are not competing against each other.
We just want to compare the students' feedback from different perspectives.
We used Microsoft Excel to analyize the survey data.

RESEARCH RESULTS

Reliability Tests

We performed reliability tests for internal consistency of the survey instrument (consistency among the questions). Does it consistently measure what it intends to measure? Cronbach's alpha is often used to measure the internal consistency with attitude instruments that use the Likert scale. Dr. Todd Grande (2016) introduced how to calculate Cronbach's alpha using Microsoft Excel instead of using SPSS on Youtube (Grande, 2016).

1) Excel add-in Data Analysis – ANOVA Two-Factor without Repetition generates the following ANOVA table for overall responses (business and IT majors):

ANOVA (overall responses)

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F-crit*
Rows	463.7473	64	7.246051	12.50434	2.95E-84	1.324313
Columns	52.2989	13	4.022992	6.942385	7.27E-13	1.731921
Error	482.1297	832	0.579483			
Total	998.1758	909				

Cronbach's alpha = MS (Error) / MS (Rows) = 0.579483 / 7.246051 = <u>0.920028</u>

2) To calculate the reliability for Business majors' responses using Excel Data Analytics, we utilized ANOVA Two-Factor without Repetition.

ANOVA (Business majors)

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F-crit*
Rows	294.1964	35	8.405612	12.34177	1.43E-46	1.449075
Columns	33.89881	13	2.607601	3.828682	7.08E-06	1.741699
Error	309.8869	455	0.68107			
Total	637.9821	503				

Cronbach's alpha = MS (Error) / MS (Rows) = 0.68107/ 8.405612 = 0.918974

3) To calculate the survey instrument reliability for IT majors' responses using Excel Data Analytics, we employed ANOVA Two-Factor without Repetition.

ANOVA (IT majors)

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F-crit*
Rows	81.71429	28	2.918367	6.830229	2.93E-20	1.507367
Columns	35.11576	13	2.701213	6.321994	8.73E-11	1.747105
Error	155.5271	364	0.427272			
Total	272.3571	405				

Cronbach's alpha = MS (Error) / MS (Rows) = 0.427272 / 2.918367 = 0.853592

The three Cronbach's alphas for the consistency of instrument are between 0.85 and 0.92. If Cronbach's alpha is unusual high (α>.95), it can be a result of high covariances among the test items and the redundancy of question items on the survey (UVA Library)

Hypotheses Tests

We constructed column charts for the distribution of students' responses by sub-question by group of students. We tested the two populations' variances if they are equal or unequal prior to using Excel two sample t-test. To test the two population variances, H_0: $\sigma_{business}^2 = \sigma_{it}^2$; H_a: $\sigma_{business}^2 \neq \sigma_{it}^2$., Excel add-in Data Analysis: F-Test Two-Sample for Variances is used.

The analysis of variance (**ANOVA**) for all 14 sub-questions have the same degrees of freedom (Df) and F Critical value (one-tail)

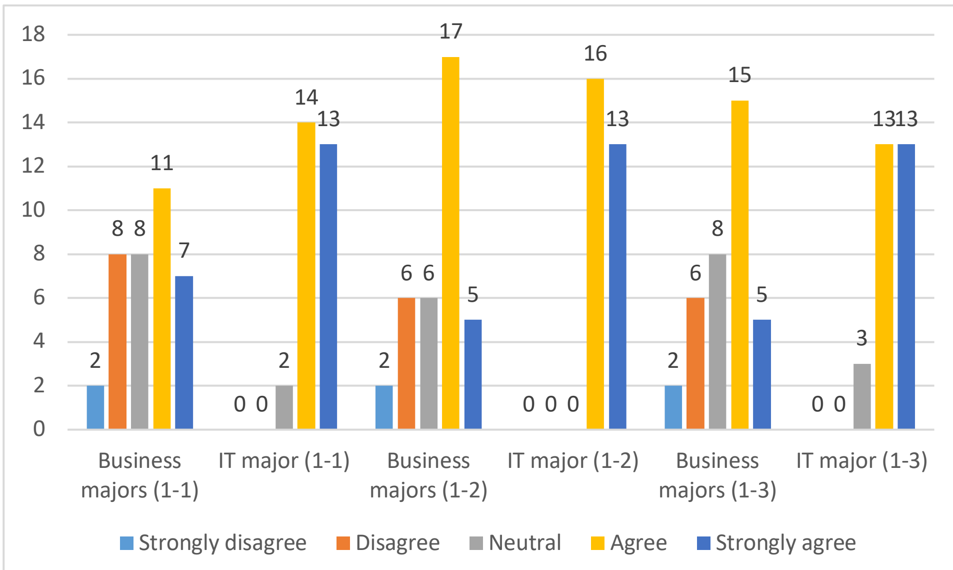
F-Test Two-Sample for Variances		
	Business majors	IT majors
Observations	36	29
Df	35	28
F Critical one-tail	1.841356	

The ANOVA tables only show F critical value as one tail, which separates the right or upper tail from the rest of the distribution. In the test of equal variances, F test calculates some form of *variances* and F statistic is always positive as a result. The higher the F statistic, the higher the variabilities. So that if the F statistic exceeds a certain threshold (F crucial value), we would reject the null hypothesis that two variances are equal.

The two-sample t-test is one of the most used hypothesis tests. It is applied to "compare whether the average difference between two groups is really significant or if it is due instead, to random chance" (Chew). The average response scores from the IT majors seem to be consistently higher than those from the Business majors. We decided to run one-tail two-samples t-test, setting the significance level $\alpha = 0.05$. Therefore, the null hypothesis is: the population mean of IT majors is less than or equal to the mean of Business major for each test item. That is, $H_0: \mu_{it} \leq \mu_{business}$; alternative hypothesis, which is the claim – the population means of IT majors is greater than the mean of Business majors for each test item. That is, $H_a: \mu_{it} > \mu_{business}$. There are two options available for two-sample t-test: t test two-sample assuming equal or unequal variances. If the two population variances are equal, the two normal distributions converge into one normal distribution to have a pooled-variance and highest degrees of freedom (Df), n – 2 (i.e. (29 + 36) - 2 = 63).
The higher the Df, the smaller the t critical value, which will make it more difficult to reject the null hypothesis.

Data Analysis

1 To what extent do you agree or disagree with the statements about the expected benefits from using SAP?



1-1 I have learned to choose approximate SAP transaction code for specific business process.
1-2 I have learned to use appropriate SAP steps for completing a task.
1-3 SAP helps me to improve the understanding of issues about integrated enterprise processes.

Descriptive statistics

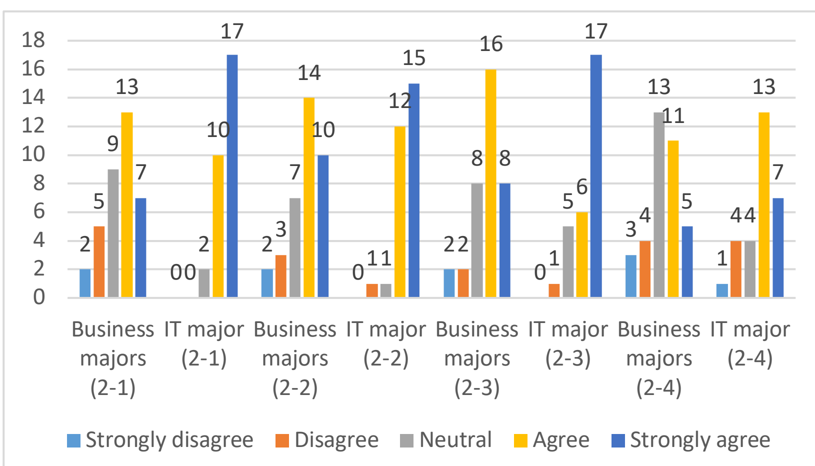
	1-1		1-2		1-3	
	Business	IT	Business	IT	Business	IT
Mean	3.361111	4.37931	3.472222	4.448276	3.416667	4.344828
Variance	1.437302	0.3867	1.227778	0.256158	1.221429	0.448276

Hypotheses testing results:

#	ANOVA		t-Test: Two-Sample Assuming Unequal Variances			
	F	P(F<=f) one-tail	Df	t Stat	P(T<=t) one-tail	t Critical one-tail
1-1	3.716844	0.000306	55	4.41199	2.41E-05	1.673034
1-2	4.793056	2.82E-05	51	4.71035	9.7E-06	1.675285
1-3	2.724725	0.003916	59	4.17657	4.95E-05	1.671093

Regarding the expected benefits from using SAP, the responses for the three sub-questions, the means of business students are between 3 and 3.5, the means of IT students are between 4 and 4.5. It is evident from the column charts that there are no negative responses from the IT group for any of the sub-questions. The variance of the responses from business majors are much wider than those from the IT majors. The most significantly unequal variances are from responses to sub-question 1-2: I have learned to use SAP steps for completing a task. We accept the alternative hypothesis that IT majors' responses are significantly more positive than business majors' at p<0.00005 for all three sub-questions. The IT majors have significantly better understanding of how to quickly access information and implement tasks in an ERP system. They also understand issues of integrated enterprise processes much better than the business majors.

2 To what extent do you agree or disagree with the statements about the expected benefits from SAP resources?



2-1 Use of the SAP on-line access helps me understand what ERP and SAP are.
2-2 The step-by-step handouts help me understand how SAP and ERP work.
2-3 One of the drawbacks of the SAP resources is that it is not very flexible (i.e. you must follow the steps on the handouts exactly as provided, otherwise it will not work.
2-4 Some of the steps described in the handouts are not working.

Descriptive statistics

	2-1		2-2		2-3		2-4	
	Business	IT	Business	IT	Business	IT	Business	IT
Mean	3.5	4.5172	3.75	4.4137	3.7222	4.3448	3.3055	3.7241
Variance	1.2857	0.4014	1.2785	0.5369	1.1206	0.8054	1.2468	1.2068

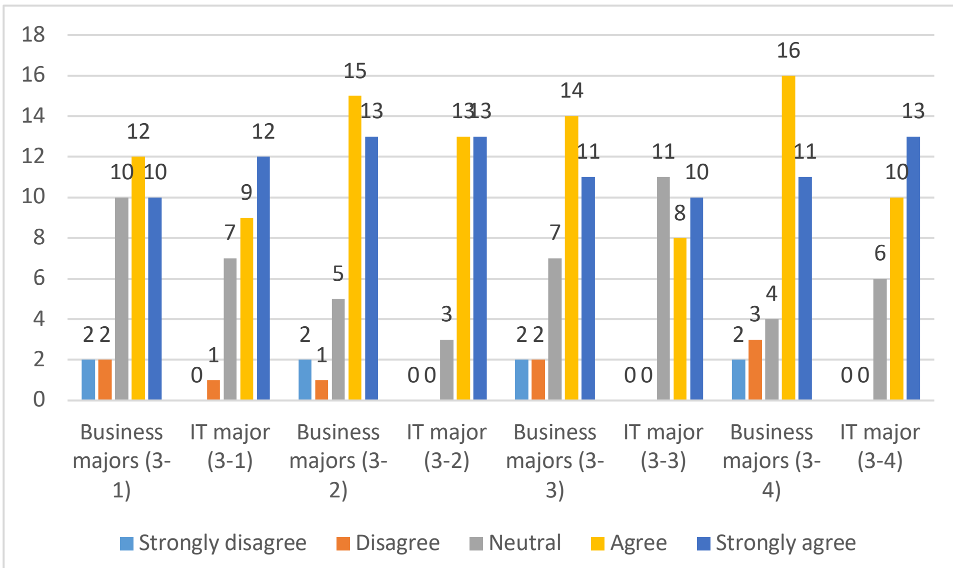
Hypotheses testing results

#	ANOVA		t-Test: Two-Sample Assuming Unequal Variances				
	F	**P(F<=f) one-tail**	**Pooled variance**	**Df**	**t Stat**	**P(T<=t) one-tail**	**t Critical one-tail**
2-1	3.202454	0.001097		57	4.56947	1.33E-05	1.672029
2-2	2.381193	0.010283		60	2.85568	0.002945	1.670649
			t-Test: Two-Sample Assuming Equal Variances				
2-3	1.391369	0.18594	0.980539	63	2.51985	0.007144	1.669402
2-4	1.033084	0.469449	1.229079	63	1.51316	0.06762	1.669402

Regarding the expected benefits from SAP resources, the average response for each of the four sub-questions from the business majors is between 3.3 and 3.8, while the average response from the IT majors is between 3.7 and 4.6. The F-test Two-Sample for variances results indicate the difference between the variabilities of the two samples for sub-question 2-1 is statistically more significant than that of sub-question 2-2 ($p < 005$ vs. $p < 0.05$). There is more variability in Business majors responses to sub-question 2-1: Use of SAP on-line access helps me understand what SAP and ERP are. One of the reasons is that the SAP ERP case study instructions use SAP GUI (graphical user interface) screen captures, which are slightly different from the on-line access user interface. Moreover, IT majors have better understanding of SAP and ERP via using SAP on-line access, and a better understanding of how SAP and ERP work via the step by step handout at $p< 0.00005$ and $p<0.005$ level respectively.

For sub-questions 2-3 and 2-4, the two sample variances are not statistically different at $p < 0.05$ level. However, the IT majors do not like the SAP resources more than the Business majors at $p < 0.05$. There is no significant difference in the average responses for "some of the steps described in the handout are not working" from the two groups of students.

3 To what extent do you agree or disagree with the statements about the expected benefits from SAP?



3-1 Useful in fulfilling my career objectives.
3-2 Enhances my employment opportunities.
3-3 Likely to increase my earnings in the future.
3-4 Likely to increase my competitiveness in job market

Descriptive statistics

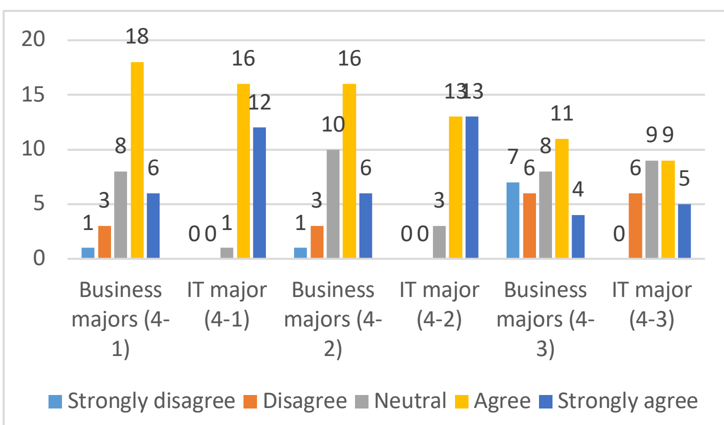
	3-1		3-2		3-3		3-4	
	Business	IT	Business	IT	Business	IT	Business	IT
Mean	3.7222	4.1034	4	4.3448	3.8333	3.9655	3.8611	4.2414
Variance	1.2349	0.8103	1.1428	0.4482	1.2285	0.7487	1.2658	0.6182

Hypotheses testing

#	ANOVA		t-Test: Two-Sample Assuming Equal Variances				
	F	P(F<=f) one-tail	Pooled variance	Df	t Stat	P(T<=t) one-tail	t Critical one-tail
3-1	1.523945	0.127305	1.04622	63	1.4937	0.070122	1.669402
			t-Test: Two-Sample Assuming Unequal Variances				
3-2	2.549451	0.006377		60	1.58713	0.058869	1.670649
			t-Test: Two-Sample Assuming Equal Variances				
3-3	1.64079	0.09049	1.015326	63	0.52574	0.30046	1.6694
			t-Test: Two-Sample Assuming Unequal Variances				
3-4	2.047587	0.027156		62	1.60007	0.057334	1.669804

Regarding the expected benefits from SAP, in the descriptive statistics table, all the sample means of IT group are greater than those of the Business group, and all the variances of Business group are greater than the IT group's variances. However, hypotheses testing can't reject the null hypotheses that the responses from the two groups of students have equal variances for sub-questions 3-1 and 3-3. Moreover, statistically there is no difference that both groups of students feel confident that learning SAP is useful for fulfilling their career objectives, enhances their employment opportunities, likely to increase their earnings in the future and their competitiveness in the job market.

4 To what extent do you agree or disagree with the statements about your satisfaction of SAP course



4-1 Satisfaction of the SAP related courses in learning about integrated enterprise processes
4-2 Satisfaction of the content of courses
4-3 SAP course did not take more time and effort

Descriptive statistics

	4-1		4-2		4-3	
	Business	IT	Business	IT	Business	IT
Mean	3.69444	4.37931	3.63889	4.34483	2.97222	3.44828
Variance	0.90397	0.31527	0.92302	0.44828	1.74206	1.04187

Hypotheses testing

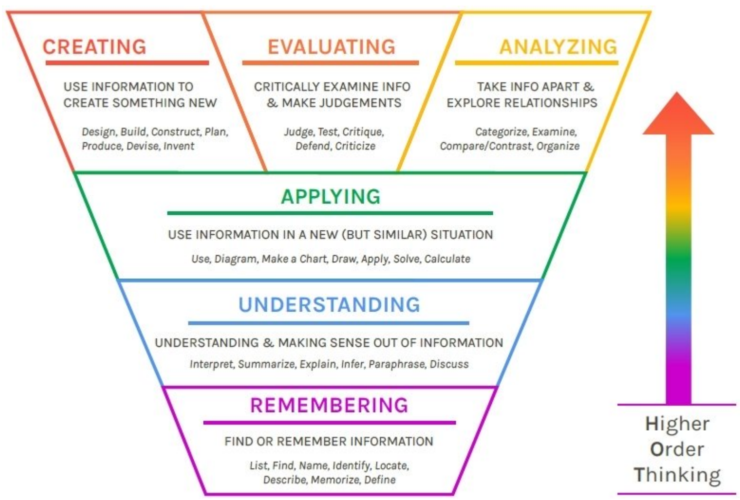
#	**ANOVA**		**t-Test: Two-Sample Assuming Unequal Variances**				
	F	**P(F<=f) one-tail**	**Pooled variance**	**Df**	**t Stat**	**P(T<=t) one-tail**	**t Critical one-tail**
4-1	2.867274	0.002656		58	3.61048	0.000319	1.671553
4-2	2.059035	0.026255		62	3.48226	0.000459	1.669804
			t-Test: Two-Sample Assuming Equal Variances				
4-3	1.672051	0.082534	1.430867	63	1.59496	0.057863	1.669402

Regarding student satisfaction of the SAP course, consistently the average responses from the IT group are greater than those from the Business group and the Business Group's responses have wider variabilities than the IT group's for all three sub-question items. The differences of variances for sub-questions 4-1 and 4-2 are quite significant at $p < 0.005$ and $p < 0.05$ respectively. The IT majors are much more satisfied with the SAP and course content at $p < 0.0005$ significance level. It looks like Business Majors spent more time and effort to complete SAP hands-on case studies (sub-question 4-3), but hypotheses testing results show there is no differences in variabilities and means between the two groups of students about how much time and effort taken to do SAP course work.

DISCUSSIONS

For every sub-question the average response from the IT majors is more positive than the Business majors. While the IT majors' responses are more concentrated on 3 – Neutral or above, Business majors' responses are distributed wider over all 5 levels, from Strongly disagree to Strongly agree. Some Business major students may have struggled to complete the hands-on case studies, but statistically, there is no difference that both majors do not take more time and effort to do SAP hands-on exercises than non-SAP courses' work. The biggest difference (at $p < 0.00005$ significance level) between the two groups of students is that Business students have more difficulty to convert the step-by-step hnads-on experience to a higher level of understanding about what SAP technology and ERP system are and how the systems work. IT major students have a higher level understanding about how SAP ERP systems work because they have more basic knowledge of how to design, implement, support and manage computer information systems.

In general, both majors feel confident that the knowledge and skills of SAP technology they learned will make them more competetive in the job market, help them achieve their career objectives, increase their employment opportunities and earnings. From potential employers' perspective, however, they are more concerned about younger employees' learning and thinking behavior, especially critical thinking, problem-solving, teamwork and professional communication skills (Bohanon, 2019).



Bloom's Taxonomy Source https://www.knowatom.com/hubfs/slide2-10.jpg?t=1513874781543#keepProtocol

Students, especially Business majors need to improve their analytical skills. SAP hands-on case studies break down ERP system into several modules, including procurement, order fulfillment, and production planning, etc. Each module is broken down to tasks and students implement those tasks step by step following detailed instructions. Survey results indicate some Business majors have difficulty to comprehend the data input required for business processes and the logical relationships among the various busienss functionalities. They tend to treat each step as isolated individual and ignore those steps as necessary parts of a whole process.

Students also need to improve their evalution skills. Both groups of students find that SAP hands-on exercises are not flexible and some steps in the handout even do not work. There are steps in the hands-on exercises that guide the students to verify the status of their implementation progress. Students often skip those steps to get their work done faster. The steps skiped may result in extra time for troubleshooting and fixing the problems in subsequent steps. The hands-on case studies are not just point-and-click, it requires critical thinking, problem solving and decision making skills.

Analytical and judgemental thinking skills are higher-order thainking skills and the bases for creative and innovative thinking skills that industry leaders are looking for, but the lower-order thinking skills are the bases of higher-order thinking skills. When we develop students' complex thinking skills, we should not ignore the fact that they are based on the simpler thinking and learning skills. For subquestion 1-1, some students do not remember using transaction code to access business processes. Prior to working on the case studies, students were introduced to the use of transaction code for accessing a specific transaction.

Although, Business majors are relatively weaker in understanding SAP technology and ERP systems, they are more specialized in business skills, such as management, marketing, accounting, finance, human resources and management informaiton systems. The IT majors have a stronger technology background but they may not have very rich, in-depth business knowledge. Therefore, in higher education and the complex business environment, younger generation is expected to have professional communication skills and work collaborately as a team.

CONCLUSION

While every company now is continuously reinventing its business with technology at the core (Edmead, 2018), countries, enterprises and educational institutions strive to boost skilled workforce. As technology advances at a faster pace, higher education and industry leaders realize that pushing students to learn technology is not enough, technology and higher-order thinking must go hand in hand. Recently, more research efforts are focused on developing students' higher-order thinking skills, including critical thinking, problem-solving, creative thinking and decision-making skills.

We used SAP ERP hands-on case studies as experimental technology tool to assess and evaluate our students' understanding of technology and higher-order thinking skills.

We compared the students' survey feedback about their SAP ERP learning experience from business majors at one college and information technology majors at another college. Students from the two institutions were surveyed separately using the same instrument. The survey data was analyzed using Microsoft Excel. The survey results show the students in both institutions recognized that learning SAP ERP application software could make them more competitive in the job market. The results also reveal that the IT majors with stronger technology background had a better understanding of business processes integration. However, when encountering: "steps not working in the handout", students in both groups had issue to troubleshoot and solve the problems. The strengths and weaknesses of different academic backgrounds indicate the importance of developing students' higher-order thinking skills, including collaroration, teamwork, and professional communication skills when developing their technology skills in higher education and at workplace.

To close the skills gap, when incorporating technology to develop, improve and promote higher-order thinking skills, we cannot just depend on a few hands-on exercises. It takes time and effort for faculty to plan and implement effective comprehensive curricula. The process to develop students' professional skills and higher-order thinking and learning behavior cannot solely depend on higher education; university and colleges should work with industry for students to take internship and receive mentoring from the potential employers.

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