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Improving Collaboration in Ambiguous Settings by Recognizing the Importance of a Common Domain Vocabulary: An Active Learning Exercise

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Abstract:

This paper investigates the impact of an active learning exercise designed to help undergraduate IT/IS (Information Technology/Information Systems) and business students recognize the importance of a common domain vocabulary for collaboration in the ambiguous settings which will be endemic in their careers as IT/IS professionals. We provide preliminary results to promote further research. We also investigated and assessed the robustness of our learning exercise with students with high exam performance and with low performance, and with students in the US and China, all showing improved recognition of the importance of a common domain vocabulary for collaboration. We present relevant literature, provide a detailed description of our active learning exercise, discuss our preliminary findings, identify limitations, and suggest future research.

Keywords: Active Learning, Collaboration, Common Domain Vocabulary, Undergraduate It/Is Education.

[Note: This study has not been previously published and it not currently under consideration elsewhere. *Opinions, conclusions and recommendations expressed or implied within are solely those of the authors and do not necessarily represent the views of USAFA, USAF, the DoD or any other government agency*.

Permission to evaluate human subjects for this study was obtained from Bowling Green State University Institutional Review Board (Exemption #1513508-1) which determined this project is exempt from IRB review according to federal regulations, and the United States Air Force Academy Institutional Review Board (FAC #20200026N): Public Release #: USAFA-DF-2020-421.]

1 Introduction

Collaboration has long been important in business, but with the explosion in available data, the need for collaboration in many different business fields is greater than ever (Craig, Assis, Bittencourt, Nativi, & Tolosana-Calasanz, 2017; Latham Gross & Whitte 2013; Panetto & Cecil, 2013). Collaboration enables professionals to interpret a variety of complex data, coordinate their actions, and integrate their efforts (Wang, 2021). While the benefits of collaboration are well established, helping students develop collaborative skills has proven difficult (Chan & Hodgson, 2009; Halatin & Eure, 1992; Scott, 2009, Sturner, Bishop & Lenhart, 2017).

Fundamental to collaboration is a common domain vocabulary (Chen, 1994; Harvey & Koubek, 2000; Jeffery, 2003; Peters, 2019). A common domain vocabulary is essential as it helps collaborators overcome the ambiguity of data (Barley, Leonardi, & Bailey, 2012; McKinney & Bhatia, 2022). We present a robust active learning exercise designed to help students recognize how a common domain vocabulary improves collaboration, especially in the ambiguous settings that are endemic for IT/IS professionals.

We also investigate the robustness of the exercise, addressing the recognition of the importance of common vocabulary for collaboration of students with high exam performance and students with low performance, and comparing students in the US (United States) and China. Our contribution is the description of the exercise, our experience using it, and our findings that suggest students in both countries recognized the importance of common domain vocabulary for collaboration in ambiguous settings. We feel this is particularly significant for IT/IS professionals working with the ambiguity associated with a data rich environment. We hope our preliminary findings encourage future research.

2 Background

2.1 Active Learning

Active Learning is a time-proven pedagogy that emphasizes active involvement versus passive listening (Beard & Wilson, 2006; Prince, 2004; Valenti, 2015). Active learning involves students in an activity that leads them to reflect on how to employ lessons in their own lives, and emphasizes skill development rather than only content transmission (Bonwell & Eisen, 1991; Michael, 2006) and encourages valuable outcomes including improved collaboration, leadership, conflict resolution, and cooperation (Herrmann, 2013; Johnson, Johnson, & Smith, 1991). Use of active learning can improve mastery of content, skill development in thinking and writing (Bonwell & Eison, 1991), critical thinking and collaboration (Styers, Van Zandt, & Hayden, 2018).

There are many different approaches to active learning in higher education (Johnson, Johnson, & Smith, 1991); including cooperative learning (Azizan, Mellon, Ramli, & Yusup, 2018; Johnson, Johnson, & Smith, 1998, 2007, 2014), collaborative learning (De Hei, Strijbos, Sjoer, & Admiraal, 2015), experiential learning (Kolb & Kolb, 2009; Reynolds & Vince, 2007), self-regulated learning (Pintrich, 1995), and project-based learning (Kokotsaki, Menzies, & Wiggins, 2016). All of these pedagogical approaches advocate a wide range of activity based approaches to education that directly involves students, or trainees, by creating a meaningful learning experience (Beard & Wilson, 2006; Prince, 2004).

Active learning has grown with a philosophical shift from teaching to learning (Barr & Tagg, 1995), including the adoption of many new pedagogies and a focus on measuring their impact on students (Astin, Keup, & Lindholm, 2002; Michael, 2006). New technology-rich classrooms and flexible, multimodal, and various authentic learning experiences, accelerated active learning transformation (Valenti, 2015). Lizzio and Wilson (2004) found that active learning has the potential to help students' professional capabilities with what they called an on-campus practicum. MacVaugh and Norton (2012) also observed the benefits of active learning while introducing sustainability programs into business education.

Although lecture has been the dominant method in IT/IS (Information Technology/Information Systems) courses (Gudigantala, 2013) there are many acknowledged benefits of adopting active learning for IT/IS students (Goh, Di Gangi, & Gunnells, 2020; Misseyanni, Papadopoulou, Marouli, & Lytras, 2018). Flipped classrooms for IT/IS undergraduates have led to some documented improvements in student attitudes, ownership, and responsibility toward learning (Mok, 2014). Pirker, Riffnaller-Schiefer, and Gütl (2014) found that motivation and engagement in computer science students increased with a decrease in dependence on educators. Several studies of IT/IS students indicated enhancement in student learning,

classroom excitement, and teamwork (Astani, 2006; Mukherjee, 2005; Van Slyke, Timmer, & Kittner, 1999). Recent studies have shown improvement on outcomes in an online IS foundations course (Goh, Di Gangi, & Gunnells, 2020) and IS strategy courses (Woods, 2020). Drake (2012) claims increased research regarding how best to use active learning in the Introductory IS course should be conducted. Another recent study (Abukhader, 2022) suggests using self-regulated strategies, and calls for more active learning options for IS courses. However, not all studies found positive effects of active learning on student learning outcomes (ELMALEH, Miller, & Goodman, 2008; Fellers, 1996; Wehrs, 2002).

Active learning can improve enrollment by reducing the number of students prematurely leaving schools or programs (MacVaugh & Norton, 2012; Specht 1985; Theobald et al., 2020). While enrollment is important to all business disciplines, retaining students in IT/IS, especially among minorities and women, has become a priority. Recent research have linked active learning in STEM (Science, Technology, Engineering, and Math) classes with better performance, greater diversity, more equity, and fewer withdrawals (O'Leary et al., 2020; Theobald et al., 2020). The IT/IS field is particularly sensitive to continuing to enroll a diverse student population; consequently exercises, including the one described in this paper, are essential (MacVaugh & Norton, 2012; Mok, 2014; Pirker, Riffnaller-Schiefer, & Gütl, 2014).

2.2 Active Learning Robustness

In this paper, we attempt to evaluate the robustness of our active learning exercise on recognizing the importance of a common domain vocabulary for collaboration in ambiguous settings. In the past several years we have used our exercise in a wide variety of IS courses, both undergraduate and graduate, in a variety of countries. Anecdotally we noticed improved retention and recall of the collaboration lesson in a variety of students. Here we report on data collected from two courses—one in a US university and one in China. We briefly review the literature on differences in US and China, and the literature on different levels of student performance. However, our paper makes no cultural or performance attributions or explanations, only that the active learning exercise can work in different places, and with both kinds of students in two very different locations.

Business school educational pedagogy in China differs in some important aspects. Cheng (2010) summarizes Chinese education rewards "rote learning", essential to climbing the social ladder, driven by extrinsic motivation of family or social expectations, and measuring success is often by standardized examinations. The Ministry of Education has called for more support for learning attitudes and values, more relevance, less rote learning, more student participation and real-life experience, and less centralization for more local adaption and choice (Cheng, 2010). However, in some instances, teachers still view the chief objective is preparation for public exams, and consequently oppose educational reforms (Cheng, 2010). Several studies indicate mixed improvement with these recent reforms (Spangler, 2016). For example, Xu (2019) found in general, Chinese teachers still do not encourage student innovation and teamwork.

In addition to differences in pedagogy, differences in US and Chinese culture and language may lead to different performance in active learning exercises. Considerable research in China, the US, and other countries (Hofstede, 1980; Xiumei & Jinying, 2011) identify cultural differences in power distance, conflict avoidance, collectivism, tolerance for ambiguity, and language context. These differences may affect learning styles and reasonably the performance of Chinese and US students on active learning exercises. Language and learning (Zhang, Li, Liu, & Chen, 2020), and its effect on a common domain vocabulary, may also play a role, because Chinese is more context dependent than English (Aaronson & Ferres, 1986; Galligan, 2001).These differences may have contributed to the infrequent use and some inconsistent results in active learning studies involving Chinese students.

Culture may also have an impact on active learning. The cultural dimension of individual-collectiveness may have an impact on the effectiveness of the case study method. For example, in individualist cultures, the case teaching method has shown to be particularly effective in one study (Mingst, 2019). Several authors (Dick, 1992; Kirschner & Sweller, 2006; Perkins, 1991) are critical of how little active learning research examines the demands made on the learners, the learners' diverse backgrounds, and the expected learning outcomes of students from constructivist cultures. These aspects may be particularly significant in mixed nationality classes, where linguistic difficulties and cognitive and cultural barriers might represent important obstacles to the effectiveness of these pedagogies (Brown, 2008). Recent studies contrasted Chinese students' Confucian learning style with objectivist Western learning styles, suggesting that many teachers find difficulties in enacting active learning with Chinese subset (Simpson, 2017). Other research suggests that active learning pedagogy is only effective to the extent student have

socialized into them (Greenholtz, 2003; Hu, 2002; Stanley, 2011). With many Chinese and non-Western students in Western classrooms, our paper helps evaluate if the long established advantages of active learning are sufficiently robust to overcome language, culture, and pedagogical differences.

In both the US and China, we assessed retention for both high performing and low performing students. Specifically, do students who score better on exams also retain and recall active learning lessons better? Research suggests high and low performing students differ with respect to learning styles (Velasco, et al., 2015), study habits, rest, self-esteem and other characteristics (Cerna & Pavliushchenko, 2015). We are aware of no research that explicitly compared active learning retention among students with different performance levels.

2.3 Collaboration and a Common Domain Vocabulary

Collaboration is, "a situation where two or more people learn or attempt to learn something together" (Dillenbourg, 1999, p.1), and is particularly essential for the contemporary evolving distributed workplace (Greer, et al., 1998) where the reliance on collaboration has been growing (Hackman & Hackman, 2002), as well as higher education graduates (Latham, Gross, & Witte, 2013; Lingard, et al., 2012).

Additionally, there is a new unstable business environment ushered in by various responses to the Covid-19 Pandemic (Byrnes, Kiely, Dunne, McDermott, & Coffey, 2021; Janssen & Van Der Voort, 2020) which is profoundly affecting our concept of collaboration and business communication in general (Knight, 2020). On the whole, collaboration today can be viewed as more "diverse, dispersed, digital, and dynamic." (Haas & Mortenson, 2016, p.70).

Collaboration is a common goal in many levels of education (Daniels & Walker, 1996; Gamson, 1997; McKeachie, 1994) and its beneficial effects of collaboration on learning are widely agreed upon in general (Hämäläinen, Niilo-Rämä, Lainema, & Oksanen, 2018), and in IS in particular (AbuJarour et al., 2019; O'Leary et al., 2020).

IS and computer science education is often highly collaborative because of the focus on creativity and finding solutions to ambiguous or ill-defined problems. Thus, both secondary education (K-12 CS Framework, 2016; Rutstein, McElhaney, & Bienkowski, 2019) and undergraduate curricula (ELMALEH, Miller, & Goodman, 2008) emphasize collaboration skills in information and technology-oriented courses.

However, collaboration is a difficult skill to teach (Scott, 2009). In particular, collaborative exercises are difficult to create (Zagel, Rick, & His, 2006), because often participants do not act with expected game behaviors (Nacke, Grimshaw, & Lindley, 2010). Despite being a common goal, little research has been conducted on how to design active learning exercises to teach collaboration well (Hämäläinen, et al., 2018; Patel, Pettitt, & Wilson, 2012; Scott, 2009). Active learning emphasizes collaboration; it places the learner in the position where they can experience both convergent and divergent opinions and thoughts (Benz, Wysocky & Miller, 2004; Penn, 2008). Students who are enculturated with the banking model of education (Freiré, 1970) expect to passively absorb the ideas of the instructor, and later make withdrawals of the information on exams, might be resistant to the idea they are teaching themselves about collaboration (Miller & Benz, 2008).

Effective collaboration depends on communication (Hackman & Johnson, 2013; Kara & Zellmer-Bruhn, 2011; Patel, Pettitt, & Wilson, 2012). Communication is "the exchange of information and the transmission of meaning" or a process by which information is shared so work is accomplished (Katz & Kahn, 1966, p. 223). A shared coding scheme and/or common language is vital to effective communication (Harvey & Koubek, 2000; Padgett & Wolosin, 1980; Peters, 2019; Wolosin, 1975). An excellent example of a common vocabulary is in the accounting profession where CPAs (Certified Public Accountants) share a common domain-specific vocabulary about what different financial data means. For accounting, their common domain vocabulary is embraced by other disciplines within the business community to more accurately and reliably communicate organizations' financial condition and other reporting requirements. For this reason, accounting is often referred to as the "language of business." (Buffett, 2015).

However, every domain has a vocabulary different professionals use to identify and describe problems and solutions, including business process improvement, supply chain, and database management. Likewise, teams often create a common vocabulary (Fussell & Krauss, 1989; Harvey & Koubek, 2000). A lack of such a common domain vocabulary is affecting progress in data science (Patil & Bhavsar, 2021).

A common domain vocabulary is also necessary to enable individuals on teams to "mutually accept" other team members' references as a conversation proceeds. This common domain vocabulary forms the shared grounding, a "common ground" necessary for the interactional dynamics (Fussell & Krauss, 1989) that lead to communication, collaboration, and other 21st century skill development (Qian & Clark, 2016).

Active learning, with its emphasis on student involvement is an excellent pedagogy to teach the skill of collaboration. In our active learning exercise, students communicate in teams and can observe first-hand how collaboration develops as vocabulary becomes common. The shared vocabulary such as the color, dimensions, and orientation of pieces of an exercise relative to other pieces (e.g. parallel, overhanging etc.) becomes established and consistently employed; improving team performance.

2.4 Ambiguity in Data

We observed in recent years that students appreciate the need for collaboration when they recognize data is ambiguous. Data, and its challenges are the core elements in our IS courses, and essential concepts for contemporary business students. Ambiguity in data is not new (Prigogine & Stengers, 1997). However, the advent of "big data" has made the ambiguity of data more pronounced (Kim et al., 2014).

We define ambiguity to reflect multiple reasonable interpretations of data (McKinney & Bhatia, 2022; McKinney & Shafer, 2021), and can be viewed as the opposite of certainty. While most professional analysts are likely to be aware of ambiguity in data, students vary. Medical education is beginning to use discussions of works of art to encourage students to look carefully and verbalize interpretations to develop skills in ambiguity, empathy and collaboration (Bentwich & Gilbey, 2017). When an individual is aware of the ambiguity in data, he or she realizes the data can mean many things, no one can be certain their interpretation is the "right one", and collaboration is necessary. Some people may have a simplistic view that there exists a single correct interpretation of data. While these individuals are at a disadvantage where flexibility is required, they are at a particular disadvantage when collaboration is valuable, and this simplicity can harm the development of collaboration skills (Bentley, 2012; Handy, 2011; Wheatley, 2006).

Simply put, data is ambiguous, by itself it does not clarify the meaning individuals attempting to collaborate should apply. To reduce the ambiguity, collaboration with a common domain vocabulary becomes essential for reaching agreement about what the data means and choosing a course of action (Larsson, 2003; Sandusky & Gasser, 2005). A common example is accounting data. When accountants collaborate to interpret accounting data, they share a common language which leads to a shared understanding. And even though, as previously mentioned, accounting is often referred to the language of business (Buffett, 2015); when discussions move from the common domain of accounting to the greater general business domain, ambiguity increases. For example, when accountants discuss the same accounting data with non-accountants more ambiguity is present and shared understanding is diminished.

McKinney and Bhatia (2022) explain the persistence of ambiguity in data by "underdeterminism" and induction. Underdeterminism purports for every interpretation or theory that explains data, there are also other interpretations or rival theories, which explain the data. The data literally under-determines the interpretation of it, in all cases.

Our reliance on induction also reveals the ubiquity of ambiguity. Induction is often used in reasoning; such as "THIS" sample applies to "THAT" population, but there is always ambiguity about which population. For example, does "THIS" particular sample of declining sales data generalize to "THAT" population of declining sales leads to significant problems; or should it generalize to "THAT" population that declines can be attributed to seasonal issues. These examples of induction are very broad, but suggest that ambiguity is as common as induction.

Recent studies suggests students vary widely in awareness of ambiguity (McKinney & Bhatia, 2022; McKinney & Shafter, 2021). In our exercise we are not attempting to clarify data or reduce ambiguity, instead we use awareness of ambiguity to improve students' ability to recognize the need for collaboration. Likewise, the greater the appreciation of a common domain vocabulary, improvements to collaboration in ambiguous settings are achievable. Our active learning exercise, the Looker-Feedbacker game, is how we address these impressions.

3 Active Learning Exercise: the Looker-Feedbacker Game

We employ an active learning approach commonly called the Looker-Feedbacker game. While the exact origin this exercise is unknown, it has similarities to the "Lego-man Game" (Reddy, 1975; Reddy & Kroger,

1972) and has also been implemented in various experiential exercises including to highlight leadership styles (Grimard, 2019). At any education level, classroom use of this type of exercise helps emphasize the importance of collaboration, and particularly the role of a common vocabulary for an effective team.

For this paper, we report on our use of the Looker-Feedbacker game at an undergraduate Introduction to IS course at a mid-western AACSB (Association to Advance Collegiate Schools of Business) accredited university, and at a large Chinese university, accredited by Chinese Ministry of Education; the course title, textbook, evaluations, and topics were the same in both countries. Execution of the game occurred over two semesters in four US sections, and in one Chinese section during the same semester. Delivery of the Chinese offering was to an English-speaking class taught by the same professor teaching the US offerings. In both settings the Introduction to IS course included the same topics on technology, database, processes, and Excel applications.

Typically, this exercise is given during the first day of class. The exercise serves as an icebreaker, and ambiguity is never more evident than during the first day of a class. During subsequent classes, we discuss data, ambiguity, and collaboration.

3.1 Rules, Roles and Responsibilities

To play the Looker-Feedbacker game the use of a variety of different materials is possible. For this paper, we use the small, colorful toy building bricks commonly generically called Legos. The essential characteristic for material selection is that it can easily construct models having some variety in shape, color, or other attributes.

The game begins with a handout, or slide-show presentation, which describes the goal—specifically for each team to construct a Lego model that looks exactly like a pre-constructed "perfect" model which has been assembled by the instructor before class and hidden from view. Examples of perfect models are shown in Figure 1. In larger sections we create several perfect models, and there is a different pre-constructed perfect model for each team. This prevents students from looking at other teams' models. These models are located in another room adjacent to the classroom. Final instructions allow a designated staging area between the classroom and room with the perfect model.

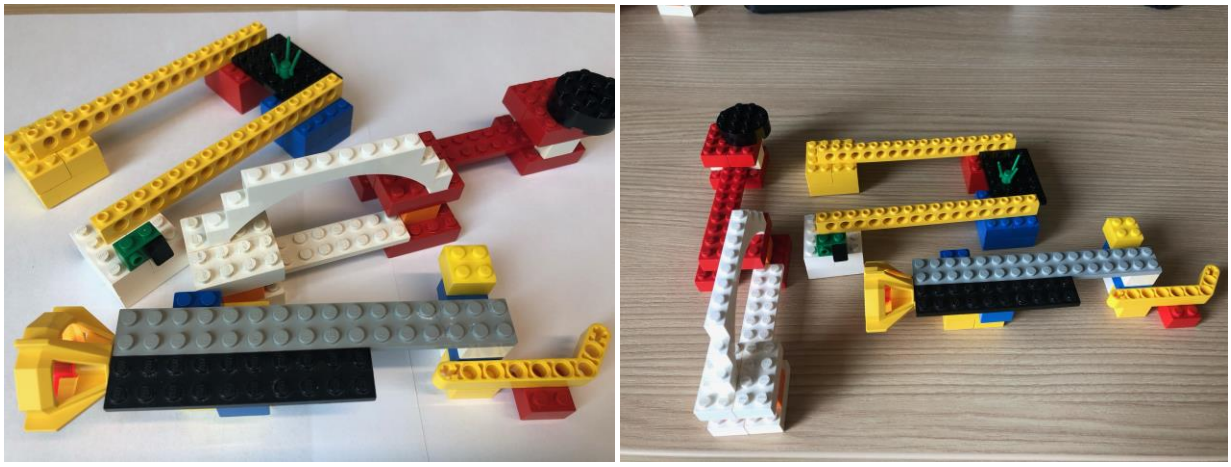

Figure 1: Examples of Perfect Model

Teams of students should be approximately the same size. In the past, we have used teams of 5 to 9 students depending on the size of the class. Whether the emphasis is on communication or collaboration, large group sizes deteriorate the learning experience in our opinion. Access to an adjacent hallway for the staging area and the size of the classroom are the only "real" limiting factors for the number of teams.

Each team has students playing one of four different roles shown in Table 1; these descriptions are shown to the class. Individual students play the first three roles. The remaining students on the team all play the fourth role.

Table 1. Student Roles

Role #1: Looker – this individual looks at the original perfect model (provided by the instructor). Can talk only to the Messenger or Feedbacker. Ensures the Messenger does not see the original perfect model. Looker is restricted from drawing any pictures. Is not permitted to see the model under construction by the Builders.
Role #2: Messenger - this individual is restricted from looking at the original perfect model, or from drawing pictures. They also cannot look at the model currently under construction by the Builders. The Looker and the Builders can talk to the Messenger. The Messenger must find a way to talk to the Builders without viewing their constructed model; Messengers may communicate with hand gestures. The Messenger can walk between the Builders' and the Looker's areas.
Role #3: Feedbacker - this individual can look at the original perfect model and the constructed model. He/she can move around freely, but cannot respond to anyone except to say; "that is correct," and/or "that is not correct." They can respond to Lookers, Messengers, and Builders. Note: photography is not permissible.
Role #4: Builder - this individual is responsible for building the constructed model. Can leave the Builders' area only to go to the supply area to collect and return pieces. Can talk to Messenger and the Feedbacker, but not allowed to view the original perfect model and prohibited from drawing any pictures. When communicating with Messenger, Builders should ensure the constructed model remains hidden from the Messenger's view.

A key aspect of the game is ambiguity. The Builders and Messengers must communicate but cannot see the perfect model; they hear descriptions of the model and must create their own interpretations of it. Further, the Looker is unsure about the status of the emerging model the Builders are constructing in the classroom, and does not know what Lego pieces are available, only the pieces in the perfect model. The Builders must create their own interpretation from the data conveyed as words spoken by the Messenger.

The Instructor has several responsibilities. The responsibilities involve setting the stage prior to the game; followed by explaining, moderating, and facilitating post-game discussions. Prior to play, after ensuring enough pieces of each model are available, original perfect models are constructed. The pre-constructed models are placed in an adjacent room (or large closet, or cross hallway). The Instructor also ensures availability of sufficient supplies and extra pieces in a designated supply area.

3.2 Game Procedures Discussion

To initiate play of the game, the Instructor announces the goal; build a model similar to the original perfect model in the hallway (or adjacent room). The Instructor then proceeds to ask each team's Looker to meet in the hallway. There the Instructor should once again highlight the rules, and assign a pre-constructed original perfect model to each team. The Instructor should do the same procedure with the Feedbackers and Messengers; repeating the rules once again. When these tasks are complete, play begins.

The Chinese students asked no questions about clarifying the roles before the start of the game; while US students often ask for clarification including, if they could write down notes, where the Feedbacker can go, and if roles are permanent. Chinese students appeared to be more goal oriented and competitive, and viewed the purpose of the exercise was to reach the goal in the quickest manner possible. Teams from both countries required the same length of time; the chatter, activity, and speed of movement were also similar. Chinese students required about the same amount of instruction-time used in US classrooms, and the game was able to start after no more than the 5-7 minutes of preamble.

Play typically lasts thirty to thirty-five minutes depending on the complexity of the original perfect model. While play continues, the Instructor must "police" Messengers who want to help build, or look, at the original perfect model. The Instructor must also ensure Feedbackers do not inadvertently give more than "yes" or "no" answers. Instructors can coach struggling teams on types of questions and how to use the Feedbacker to make incremental progress and avoid abject frustration. The Instructor is also encouraged to monitor the play of teams to address questions during the follow-on post-game discussions.

During execution of the Looker-Feedbacker game, the Instructor may notice a number of common phenomena. Most teams do not make use of the Feedbacker early, but do adapt their processes and

over time increasingly rely upon help from the Feedbacker highlighting effective collaboration. Students may even attempt to "cheat" during the process. For example, students may have Lookers peek into the classroom to see status, or write down instructions. They may also have Messengers shout to their teams from the doorway or look at the original perfect constructed model, or have Builders build their model at the supply area, or even hoard potential pieces.

The game typically starts fairly slowly. During the initial stages, teams build communication patterns based on repetition and success. During this stage, Lookers will explain the entire model to the Messengers, then realize that is pointless and after two or three conversations begin to focus on just adding one piece at a time. The Looker, Messenger, and Builders on each team slowly develop a language for orientation, for example, "This next piece goes parallel with that long piece on the base." Builders initially find it difficult to figure out how to use the Feedbacker but by the end of the game that collaboration has become more sophisticated, and vocabulary more common, as messengers learn to take the Feedbacker with them to select pieces from the Supplier, to ask if all the pieces in our constructed model thus far are perfect, and to ask if a piece they have is the one the Messenger is now describing to them. Lookers never initially ask the Feedbacker anything, but later learn to ask, "Do the Builders have this part (or piece) right?" Often in initial stages the builders will have a piece in their model that is not correct, but do not realize it. Then they add some new pieces and ask the Feedbacker if their model is correct and when they hear "no", mistakenly conclude it is the new piece that was incorrect. Once these initial stage challenges are overcome, few new processes emerge, pieces are added rapidly, and the last half the pieces are added in roughly 20% of the time required for the first half.

3.3 Post-Game Discussion

Upon completion of the game, the Instructor begins the discussion with an open-ended prompt, "What did you learn?" Obviously, student observations differ widely. Initially the students in both countries often lightheartedly scapegoat the messenger, the mistakes they all made in communication, how poorly they understood the challenges faced by other roles, and how slowly they started. US students more frequently made statements about emotions (e.g. rushed, frustration, disappointment, not enough time), and mild complaints that the game was unfair to them (e.g. other groups had easier models to build, minor pieces in the wrong place should not matter). The Chinese students were initially more formal and factual, and less accustomed to open-ended discussions. Both sets of students used the terms collaboration or teamwork without the instructor's suggestion. The main themes from the students also included the need to listen better, the difficulty in overcoming an incorrectly placed piece, and how much better they operated at the end of the session compared to at the beginning of the exercise. During the discussion, both sets of students agreed with examples and nods and smiles when the terms ambiguity and common domain vocabulary were introduced.

To introduce the topic of collaboration, we highlight the use of a common domain vocabulary; emphasizing having a common language to describe something can reduce ambiguity. To introduce the topic of ambiguity and collaboration, we ask a student to describe a given Lego piece. They typically mention color, dimensions, and orientation. While color has a common vocabulary, dimensions do not. One student when asked, may describe the dimensions of a piece of Lego by looking at the nobs on top. But another student may look at the holes on the bottom, particularly if they had never seen or played with Lego. Consequently, a typical piece is not a 2 x 4; rather a 1 x 3. Orientation is another ambiguous and uncommon vocabulary term at first which slows progress. Some students use a North and South grid, others refer to levels, and others perpendicular and parallel. When those terms are not common early in the exercise progress is limited. While teams build a common vocabulary to describe pieces and models, ambiguity is reduced and collaboration improves. Our conclusion to this in-class discussion is that it is difficult to build anything in the absence of a common domain vocabulary. We ask students to reflect upon how often in their actual business experiences, or even internships, people use vocabulary terms they do not know, and whether they can collaborate in these episodes. For closure, we emphasize that the end of their college careers is not the end of learning the common domain vocabulary of their discipline.

The Instructor can also develop several other lessons from this experience. For example, a lesson about process improvement. Interesting discussions can emerge by asking students how their team worked at the beginning of the game, compared with at the end of the game placing emphasis upon process improvement. Additional questions may include, "If you had $200, what technology would your team spend it on?" If an answer is a camera (as photography was prohibited during the actual exercise), a

follow-up question could be, “What job would change as a result of the new technology?” Students quickly realize the Looker and Messenger would need a new job, and the Builders would need to receive additional “training” on the new technology. A conclusion might be that when technology changes, all of their jobs, and even professions, may also change.

4 Findings

During the first course examination, three to six weeks after the Looker-Feedbacker exercise, we asked the students this question:

Earlier this semester we built Lego models. According to the teacher what were the key lessons to be learned from this exercise? (Mark all correct answers, there may be more than one right answer)

a. Information systems are important to business

b. Planning is the key to success

c. Vocabulary is essential to effective collaboration

d. Process improvement leads to success

e. IT improves processes

f. Involve end users early in a project

Answer “c” was correct; and the incorrect answers were evenly split among “a”, “b”, “d” and “e”; very few students selected f. The question was administered to a total of 102 US students in two sections of an Introductory IS course with a strong process focus. This sample included students representing all business majors. In China, the single section of 95 students was in an Introductory IS course comprised of mostly IS majors. Students in both countries were traditional students with little, or no, work experience. The exam content, procedures, and grading were very similar in both locations—a mix of multiple choice and essay question on topics from half the course; exactly the same Lego question was used. The exam in China was written in English.

Table 2 displays the exam results. We collected data for each student on their exam performance during the semester. We divided each cohort of students, Chinese and US, into two groups; higher performing students and lower performing students, based solely on their performance on the exams during the course. This method of comparing performance of recall of learners by classifying students into two groups is similar to evaluations of the effect of anticipated teaching (Nestojko, Bui, Kornell & Bjork, 2014); the effect of learning styles (Tie & Umar, 2010); and the effect of memory skills (Hill, Storant & Simeone, 1990).

Table 2. Exam Results

Looker-Feedbacker active learning exercise effect on retention and recall				
	Number of Students	Active Learning Question	All Other Questions	Significance
ALL US STUDENTS	102	86%	68%	<.01
Higher 50% students (strong)	51	96%	84%	<.02
Lower 50% students (weak)	51	76%	53%	<.01
ALL CHINESE STUDENTS	95	87%	65%	<.01
Higher 50% students (strong)	48	90%	76%	<.02
Lower 50% students (weak)	47	85%	55%	<.01

The data in Table 2 suggests our active learning exercise helps students recognize the lesson that common domain vocabulary is essential for effective collaboration in ambiguous environments. US student recognition improved from 68 percent to 86 percent and from 65 percent to 87 percent for Chinese students. Higher performing students did better on the active learning question than other exam questions in both countries; and lower performing students also demonstrated greater increase in performance in both locations (statistical significance of these differences found in Table 2).

These improvements are particularly impressive when motivation is considered. All other questions on the exam contributed to their overall score on the exam and in the course. Because this question would

not impact their exam score, we actually administered this single question about the game immediately prior to the exam. In addition, students were unaware that we would ask them a question about the Lego exercise.

While preliminary, we feel our paper supports the observation that active learning can help students recognize the importance of a common domain vocabulary for improving collaboration in ambiguous settings. Active learning also showed a positive result with both groups of students in both countries.

5 Discussion

This paper investigates the impact of an active learning exercise designed to help undergraduate IT/IS and business students in an Introduction to IS class recognize the importance of a common domain vocabulary for collaboration in ambiguous settings. By participating in the exercise and the subsequent discussion, students were able to witness the value for a common set of vocabulary in order to overcome the ambiguity about how to build the Lego model. We are aware of no other study examining high and low performing students in a common active learning exercise, or comparing student performance on a common active learning exercise in the US and China.

Our findings also support the idea that active learning can be used to teach collaboration, and that active learning can also help students recognize the importance of common vocabulary for collaboration in ambiguous settings. Previous research has suggested collaboration is a difficult skill for students to develop (Chan & Hodgson, 2009; Halatin & Eure, 1992; Scott, 2009; Sturner, Bishop & Lenhart, 2017).

Our preliminary finding is that both stronger and weaker students benefit from the exercise. One possible explanation for the strong student performance is that strong students are alert to lessons being delivered. Another explanation is strong students are receptive to valuable ideas, know a good idea when they hear one, and try to retain the idea. Strong student performance may actually be more impressive because of a statistical "ceiling effect" which makes discrimination among subjects at the top of a sample population difficult. Put differently, these groups started at 84 percent in the US and 76 percent in China. The better recognition by weak students on our exercise may be due to motivation. These students may perform poorly on exams due to lack of motivation, and this active exercise is motivating. Their raw score improvement is approximately twice the stronger students. However, we did not measure motivation; clearly more research on the impact of motivation is necessary.

The recognition effect was evident. Both strong and weak performing students, and students in both the US and China did well. A relatively robust exercise is essential because the diversity of student bodies in backgrounds, pedagogy, motivation and outcomes continue to grow (Hu & Kuh, 2003; Hung, Sun, & Liu, 2019). IT/IS and STEM courses need learning exercises to aid in keeping students who represent diverse populations (MacVaugh & Norton, 2012; Mok, 2014, Pirker et al., 2014), and our paper suggests, both students with high and low performance on exams may also benefit from two very different educational settings – the US and China.

In our Introduction to IS class, we did this exercise on the first day, and asked our question on the first exam, then introduced ambiguity during a last module of the class covering data. At this later point in the semester, we remind students of the Lego lesson on common domain vocabulary. We feel this exercise helps students recognize the need for collaboration after they gain greater awareness of the ambiguity in data associated with what they will encounter as IT/IS professionals. We also highlight the need for collaboration when we discuss systems analysis and design, process improvement, and decision-making.

While not the main contribution of our paper, this work also addresses use of active learning in a Chinese classroom. As stated earlier, active learning is less common in Chinese pedagogy, and in discussions afterward, with the students in this study very uncommon. Despite language, culture, and learning style differences, we observed similar effects in the Chinese sections. The positive impact of active learning on student recognition of the importance of common vocabulary for collaboration in this different setting suggest that the effects of active learning are quite robust.

The student and faculty experience were similar and different in the two counties. Students in both countries seemed to enjoy the exercise, take pride in completion, start slowly, violate rules and accept correction agreeably, and participate earnestly in the post exercise discussion. Chinese students tended to be less publicly critical of their own performance during the discussion, and some of the Chinese were less familiar with Lego which at times caused confusion about piece descriptions. The Chinese teacher who observed the exercise for the first time and helped enforce the rules did so as a supportive parent

eschewing power distance, and was surprised how quickly the models were built during the second half of the exercise.

6 Limitations and Suggested Future Research

Our results are preliminary and we offer them to promote further research. Active learning may yield different results with different, but related, experiential exercises in different disciplines. In addition, our method of using a multiple-choice question with options may have produced different results than alternative forms of evaluation, including short-answer. A short-answer question would have produced a wider variety of responses and perhaps more insight into what and how the students recalled the exercise. A single multiple-choice question was used due to the difference in ease of use of English, and also due to limited time and attention available preceding the exam. The Chinese students in particular might have needed 5 to 10 minutes to compose and write out an explanation.

The diversity of experiences of the student participants may also affect outcomes (Hu & Kuh, 2003). In addition, we chose to exclude the obvious impacts of communication during the Looker-Feedbacker exercise in order to concentrate on student recognition of the importance of collaboration in ambiguous settings, versus merely the importance of good communication. Finally, carefully developed hypotheses and a more robust empirical treatment of a much larger data set is in order.

Time and energy spent on the 35-minute active learning exercise might also influence recognition and recall of this lesson. Additionally, if other topics on the exam had exercises of the same length, the students could also recognize and recall those lessons. During the semester, we also spent 30-40 minutes describing a widely-used commercial software, which supports business processes; however the multiple choice question average for that topic was 72 percent and 68 percent at the US and Chinese school respectively. We also spent 30-40 minutes on personal safeguards on smartphones, and 30-40 minutes on databases and key fields with similar exam results. On all these extended time topics, student performance was below the active learning question.

This paper on collaboration in ambiguous setting also had many physical elements, not merely abstract concepts. Lego blocks and models had objective colors, dimensions, and orientation. Concepts such as the cloud, input validation, and architecture are more abstract. Effective collaboration and the role of a common domain vocabulary to reduce ambiguity in these abstract pursuits may be different from building physical models.

Potential future studies can also address the period of time between lesson and evaluation, to determine how time affects retention and recall. An interesting approach may be examining the recall of lessons from active learning exercises when students are aware of subsequent evaluations. Further work could also attempt to reproduce these results with control groups. Future research might also examine if active learning improves the recall and retention of other, non-collaboration, lessons.

7 Conclusion

Collaboration, essential in today's data rich business environment, can be difficult to teach. We hope that the active learning exercise described here, proves to be a valuable pedagogy and can help IT/IS and business students recognize that a common domain vocabulary is essential to collaboration in ambiguous settings. This work contributes the description of our exercise, our observations and experience with it in different settings, and preliminary support improving the recognition of the importance of common domain vocabulary for collaboration. We hope other IT/IS instructors, or even practitioners, can begin to use the exercise for these benefits and adapt it to their own context, domain vocabulary, learning objectives, and experiences. We consider this a preliminary study and suggest further study to establish the validity of our preliminary findings, and to expand on the paper with more robust sampling.

References

Aaronson, D., & Ferres, S. (1986). Sentence processing in Chinese-American bilinguals. *Journal of Memory and Language*, *25*(2), 136-162.

AbuJarour, S., Wiesche, M., Andrade, A. D., Fedorowicz, J., Krasnova, H., Olbrich, S., … Venkatesh, V. (2019). ICT-enabled refugee integration: A research agenda. *Communications of the AIS*, *44*(1), 874-891.

Abukhader, S. M. (2022). Developing a pedagogical instrument for MIS fundamental course–embracing self-regulated learning strategies. *VINE Journal of Information and Knowledge Management Systems.* Retrieved from https://www.emerald.com/insight/publication/issn/2059-5891.

Astani, M. (2006). The MIS capstone course: An active learning approach. *Issues in Information Systems*, *7*(1), 119-123.

Astin, A. W., Keup, J. R., & Lindholm, J. A. (2002). A decade of changes in undergraduate education: A national study of system transformation. *The Review of Higher Education, 25*(2), 141-162.

Azizan, M.T., Mellon, N., Ramli, R.M., & Yusup, S. (2018). Improving teamwork skills and enhancing deep learning via development of board game using cooperative learning method in Reaction Engineering course. *Education for Chemical Engineers, 22*, 1-13.

Barley, W. C., Leonardi, P. M., & Bailey, D. E. (2012). Engineering objects for collaboration: Strategies of ambiguity and clarity at knowledge boundaries. Human Communication Research, 38(3), 280-308.

Barr, R. B., & Tagg, J. (1995). From teaching to learning—A new paradigm for undergraduate education. *Change: The Magazine of Higher Learning*, *27*(6), 12-26.

Beard, C.M., & Wilson, J.P. (2006). Experiential learning: A best practice handbook for educators and trainers. London: Kogan Page.

Bentley, T. (2012). Learning beyond the classroom: Education for a changing world. Routledge.

Bentwich, M. E., & Gilbey, P. (2017). More than visual literacy: art and the enhancement of tolerance for ambiguity and empathy. *BMC Medical Education*, *17*(1), 1-9.

Benz, J. J., Wysocki, D. K., & Miller, R. L. (2004). Encouraging collaborative learning through computer-mediated conferencing or fishbowl interaction. In E. Peck (Ed.), *Compendium of teaching resources and ideas* (pp.111-124), UNK/CTE (University of Nebraska at Kearney/Center for Teaching Excellence).

Bonwell, C.C. & Eison, J.A. (1991). Active learning: Creating excitement in the classroom. In: *1991 ASHE-ERIC higher education reports. ERIC Clearinghouse on Higher Education*. The George Washington University, Washington, DC.

Brown, L. (2008). The incidence of study-related stress in international students in the initial stage of the international sojourn. *Journal of Studies in International Education*, *12*(1), 5-28.

Buffett, W. (2015). Berkshire Hathaway Letters to Shareholders. Retrieved from https://www.goodreads.com/quotes/7328691-accounting-numbers-of-course-are-the-language-of-business-and.

Byrnes, K. G., Kiely, P. A., Dunne, C. P., McDermott, K. W., & Coffey, J. C. (2021). Communication, collaboration and contagion: "Virtualisation" of anatomy during COVID-19. *Clinical Anatomy, 34(*1), 82-89.

Cerna, M.A., & Pavliushchenko, K. (2015). Influence of study habits on academic performance of international college students in Shanghai. *Higher Education Studies, 5*(4), 42-55.

Chan, L. K., & Hodgson, P. (2009). A comparison of the learning experience for full-and part-time students for having an online database of professional terminology. In *International Conference of Education, Research & Innovation*, ICERI 2009.

Chen, H. (1994). The vocabulary problem in collaboration. *Computer, 27*(5), 2-10.

Cheng, K.M. (2010). Shanghai and Hong Kong: Two distinct examples of education reform in China. In *Organisation for economic co-operation and development, strong performers and successful performers in education: Lessons from PISA for the United States* (pp. 83-115), OECD.

Craig, A., Assis, M., Bittencourt, L. F., Nativi, S., & Tolosana-Calasanz, R. (2017). Big Iron, big data, and big identity. *New Frontiers in High Performance Computing and Big Data*, *30*, 139.

Daniels, S. E., & Walker, G. B. (1996). Collaborative learning: improving public deliberation in ecosystem-based management. *Environmental Impact Assessment Review, 16*(2), 71-102.

De Hei, M.S.A., Strijbos, J.W., Sjoer, E., & Admiraal, W. (2015). Collaborative learning in higher education: Lecturers' practices and beliefs. *Research Papers in Education, 30*(2), 232-247.

Dick, W. (1992). An instructional designer's view of constructivism. In T. Duffy & D. Jonassen (Eds.), *Constructivism and the technology of instruction-A conversation* (pp. 991-998). LEA Publishers.

Dillenbourg, P. (1999). What do you mean by collaborative learning? In: P. Dillenbourg (Ed.), *Collaborative-learning: Cognitive and computational approaches* (pp.1-19). Oxford: Elsevier.

Drake, J. R. (2012). A critical analysis of active learning and an alternative pedagogical framework for introductory information systems courses. *Journal of Information Technology Education*, *11*(1), 39-52.

ELMALEH, J., Miller, S., & Goodman, P. S. (2008). Learning outcomes for a business information systems undergraduate program. *Communications of the Association of Information Systems, 23*(1), 95-122.

Fellers, J. W. (1996). Teaching teamwork: exploring the use of cooperative learning teams in information systems education. *ACM SIGMIS Database: The DATABASE for Advances in Information Systems, 27*(2), 44-60.

Freiré, P. (1970). Pedagogy of the oppressed. New York: Seabury.

Fussell, S. R., & Krauss, R. M. (1989). The effects of intended audience on message production and comprehension: Reference in a common ground framework. *Journal of Experimental Social Psychology, 25*(3), 203-219.

Galligan, L. (2001). Possible effects of English-Chinese language differences on the processing of mathematical text: A review. *Mathematics Education Research Journal, 13*(2), 112-132.

Gamson, Z. F. (1997). Higher education & rebuilding civic life. *Change: The Magazine of Higher Learning, 29*(1), 10-13.

Goh, S. H., Di Gangi, P. M., & Gunnells, K. (2020). Applying team-based learning in online introductory information systems courses*. Journal of Information Systems Education, 31*(1), 1-11.

Greenholtz, J. (2003). Socratic teachers and Confucian learners: Examining the benefits and pitfalls of a year abroad. *Language and Intercultural Communication, 3*(2), 122-130.

Greer, J. E., Mccalla, G., Collins, J. A., Kumar, V. S., Meagher, P., & Vassileva, J. (1998). Supporting peer help and collaboration in distributed workplace environments. *International Journal of Artificial Intelligence in Education (IJAIED), 9*, 159-177.

Grimard, C. M. (2019, March). Lego Mansion: an Experiential Exercise for Understanding Leadership Styles. In *Developments in Business Simulation and Experiential Learning: Proceedings of the Annual ABSEL conference* (Vol. 46).

Gudigantala, N. (2013). An active learning approach to teaching undergraduate introduction to MIS Course. *Proceedings of the Nineteenth Americas Conference on Information Systems*, Chicago, Illinois. Retrieved from https://aisel.aisnet.org/amcis2013/ISEducation/GeneralPresentations/3.

Haas, M., & Mortensen, M. (2016).The secrets of great teamwork. *Harvard Business Review*, *94*(6), 70-76.

Hackman, J.R. & Hackman, R.J. (2002). Leading teams: Setting the stage for great performances. Harvard Business Press.

Hackman, M. Z., & Johnson, C. E. (2013). Leadership: A communication perspective. Waveland Press.

Halatin, T. J., & Eure, J. D. (1992). Building a realistic business vocabulary: a challenge for educators. *Journal of Education for Business, 67*(5), 275-278.

Hämäläinen, R. H., Niilo-Rämä, M., Lainema, T., & Oksanen, K. (2018). How to raise different game collaboration activities: The association between game mechanics, players' roles and collaboration processes. *Simulation & Gaming, 49*(1), 50-71.

Handy, C. (2011). Beyond Certainty: the changing worlds of organisations. Random House.

Harvey, C. M., & Koubek, R. J. (2000). Cognitive, social, and environmental attributes of distributed engineering collaboration: A review and proposed model of collaboration. *Human Factors and Ergonomics in Manufacturing & Service Industries, 10*(4), 369-393.

Herrmann, K.J. (2013). The impact of cooperative learning on student engagement: Results from an intervention. *Active Learning in Higher Education, 14*(3), 175-187.

Hill, R. D., Storandt, M., & Simeone, C. (1990). The effects of memory skills training and incentives on free recall in older learners. *Journal of Gerontology, 45*(6), 227-232.

Hofstede, G. (1980). *Culture's consequences: Institutional differences in work-related values*. Newbury Park, CA: Sage.

Hu, G. (2002). Potential cultural resistance to pedagogical imports: The case of communicative language teaching in China. *Language Culture and Curriculum*, *15*(2), 93-105.

Hu, S. & Kuh, G.D. (2003). Diversity experiences and college student learning and personal development. *Journal of College Student Development, 44*(3), 320-334.

Hung, C.Y., Sun, J.C.Y., & Liu, J.Y. (2019). Effects of flipped classrooms integrated with MOOCs and game-based learning on the learning motivation and outcomes of students from different backgrounds. *Interactive Learning Environments, 27*(8), 1028-1046.

Janssen, M., & Van Der Voort, H. (2020). Agile and adaptive governance in crisis response: Lessons from the COVID-19 pandemic. *International Journal of Information Management, 55*,102-180.

Jeffrey, P. (2003). Smoothing the waters: Observations on the process of cross-disciplinary research collaboration. Social studies of science, 33(4), 539-562.

Johnson, D. W., Johnson, R. T., & Smith, K. A. (1998). Cooperative learning returns to college what evidence is there that it works? *Change: The Magazine of Higher Learning, 30*(4), 26-35.

Johnson, D.W., Johnson, R.T., & Smith, K.A. (1991). Active Learning: Cooperation in the College Classroom. Edina, MN: Interaction Book Co.

Johnson, D.W., Johnson, R.T., & Smith, K.A. (2007). The state of cooperative learning in postsecondary and professional settings. *Educational Psychology Review, 19*(1), 15-29.

Johnson, D.W., Johnson, R.T., & Smith, K.A. (2014). Cooperative learning: Improving university instruction by basing practice on validated theory. *Journal on Excellence in University Teaching*, *25*(4), 1-26.

K–12 Computer science framework. (2016). Retrieved from http://www.k12cs.org.

Kara, A., & Zellmer-Bruhn, M. (2011). The role of organizational culture and underlying ideologies in the success of globally distributed teams. In *The handbook of organizational culture and climate* (pp. 538-560). SAGE Publications Inc.

Katz, D., & Kahn, R. L. (1978). Organizations and the system concept. *Classics of Organization Theory, 80*, 480.

Kim, J., Diesner, J., Kim, H., Aleyasen, A., & Kim, H. M. (2014, October). Why name ambiguity resolution matters for scholarly big data research. In 2014 IEEE International Conference on Big Data (Big Data), (pp. 1-6). IEEE.

Kirschner, P. A., & Sweller, J. (2006). Richard E. Clark, why minimal guidance during instruction does not work: an analysis of the failure of constructivist, discovery, problem-based, experiential and inquiry-based teaching. *Educational Psychologist, 41*, 2.

Knight, M. (2020). Pandemic communication: A new challenge for higher education. *Business and Professional Communication Quarterly, 83*(2), 131-132.

Kokotsaki, D., Menzies, V., & Wiggins, A. (2016). Project-based learning: A review of the literature. *Improving Schools, 19*(3), 267-277.

Kolb, A.Y., & Kolb, D.A. (2009). Experiential learning theory: A dynamic, holistic approach to management learning, education and development. In *The SAGE handbook of management learning, education and development* (pp.42-68).Thousand Oaks, CA: SAGE Publications Ltd.

Larsson, A. (2003, November). Making sense of collaboration: the challenge of thinking together in global design teams. In *Proceedings of the 2003 International ACM SIGGROUP Conference on Supporting Group Work* (pp. 153-160).

Latham, D., Gross, M., & Witte, S. (2013). Preparing teachers and librarians to collaborate to teach 21st century skills: Views of LIS and education faculty. *School Library Research, 16.*

Lingard, L., McDougall, A., Levstik, M., Chandok, N., Spafford, M. M., & Schryer, C. (2012). Representing complexity well: a story about teamwork, with implications for how we teach collaboration*. Medical Education, 46(*9), 869-877.

Lizzio, A., & Wilson, K. (2004). Action learning in higher education: An investigation of its potential to develop professional capability. *Studies in Higher Education*, *29*(4), 469-488.

MacVaugh, J., & Norton, M. (2012). Introducing sustainability into business education contexts using active learning. *International Journal of Sustainability in Higher Education, 13*(1), 72-87.

McKeachie, W. J. (1994). *Teaching Tips: strategies, research, and theory for college and university teachers*. Lexington, (9th ed.). Lexington, MA: DC Heath & Co.

McKinney E. & Bhatia, M. (2022). Measuring awareness of ambiguity in a visualization, [Unpublished manuscript]. College of Business Administration, Bowling Green State University.

McKinney E., & Shafer, R. (2021, February*).* Enhancing student awareness of ambiguity: A data literacy skill*. 32nd Annual Teaching Economics Conference*, Robert Morris University. Pittsburgh, PA.

Michael, J. (2006). What is active learning and what are these new approaches to learning? *Advances in Physiology Education, 30*(4), 159-167.

Miller, R. L., & Benz, J. J. (2008). Techniques for encouraging peer collaboration: Online threaded discussion or fishbowl interaction. *Journal of Instructional Psychology, 35*(1).

Mingst, K. A. (2019). Active learning in different environments: The influence of culture in the class. In K. Mingst & K. Mori (Eds.), *Teaching international affairs with cases* (pp. 1-12). New York: Routledge.

Misseyanni, A., Papadopoulou, P., Marouli, C., & Lytras, M. D. (2018). Active learning stories in higher education: Lessons learned and good practices in STEM education. In A. Misseyanni, A, M. Lytras, P. Papadopoulou, & C. Marouli (Eds.), *Active learning strategies in higher education* (pp. 75-105). Emerald Publishing Limited.

Mok, H.N. (2014). Teaching tip: The flipped classroom. *Journal of Information Systems Education, 25*(1), 7-11.

Mukherjee, A. (2005). Use of a class exercise to maximize student interest in an introductory MIS course. *Issues in Information Science and Information Technology, 2*, 481-491.

Nacke, L. E., Grimshaw, M. N., & Lindley, C. A. (2010). More than a feeling: Measurement of sonic user experience and psychophysiology in a first-person shooter game*. Interacting with Computers, 22*(5), 336-343.

Nestojko, J. F., Bui, D. C., Kornell, N., & Bjork, E. L. (2014). Expecting to teach enhances learning and organization of knowledge in free recall of text passages. *Memory & Cognition, 42*(7), 1038-1048.

O'Leary, E. S., Shapiro, C., Toma, S., Sayson, H. W., Levis-Fitzgerald, M., Johnson, T., & Sork, V. L. (2020). Creating inclusive classrooms by engaging STEM faculty in culturally responsive teaching workshops. *International Journal of STEM Education, 7*(1), 1-15.

Padgett, V. R., & Wolosin, R. J. (1980). Cognitive similarity in dyadic communication. *Journal of Personality and Social Psychology, 39*(4), 654.

Panetto, H., & Cecil, J. (2013). Information systems for enterprise integration, interoperability and networking: theory and applications. *Enterprise Information Systems, 7*(1), 1-6.

Patel, H., Pettitt, M., & Wilson, J. R. (2012). Factors of collaborative working: A framework for a collaboration model. *Applied Ergonomics, 43*(1), 1-26.

Patil, T., & Bhavsar, A. K. (2021). Data science team roles and need of data science: a review of different cases. *Data Science and Intelligent Applications, 52*, 13-22.

Penn, B. K. (2008). *Mastering the teaching role: A guide for nurse educators*. FA Davis. Philadelphia, PA: F.A. Davis Company.

Perkins, D. N. (1991). What constructivism demands of the learner. *Educational Technology, 31*(9), 19-21.

Peters, J. (2019). High performance team coaching: an evidence-based system to enable team effectiveness. In D. Clutterbuck, J. Gannon, S. Hayes. I. Iordanou, K. Lowe, D. Mackie (Eds.), *The Practitioner's Handbook of Team Coaching* (pp. 180-191). Routledge.

Pintrich, P.R. (1995). Understanding self-regulated learning. *New Directions for Teaching and Learning, 63*, 3-12.

Pirker, J., Riffnaller-Schiefer, M., & Gütl, C. (2014, June). Motivational active learning: engaging university students in computer science education. *Proceedings of the 2014 Conference on Innovation & Technology in Computer Science Education* (pp. 297-302).

Prigogine, I., & Stengers, I. (1997). *The end of certainty*. Simon and Schuster.

Prince, M. (2004). Does active learning work? A review of the research. *Journal of Engineering Education, 93*(3), 223-231.

Qian, M., & Clark, K. R. (2016). Game-based Learning and 21st century skills: A review of recent research. *Computers in Human Behavior, 63,* 50-58.

Reddy, W.B. (1975). Diagnosing team problem-solving effectiveness: A comparison of four populations. *Small Group Behavior, 6*(2), 174-186.

Reddy, W.B., & Kroger, O. (1972), Intergroup model-building: the legoman. In J. Pfeiffer & J. Jones (Eds.), *The 1972 Annual Handbook for Group Facilitators* (pp. 36-43). Iowa City, Iowa: University Associates Press.

Reynolds, M., & Vince, R. (Eds.). (2007). *Handbook of experiential learning and management education*. New York: Oxford University Press.

Rutstein, D. W., Xu, Y., McElhaney, K., & Bienkowski, M. (2019, February). Developing Implementation Measures for K-12 Computer Science Curriculum Materials. In *Proceedings of the 50th ACM Technical Symposium on Computer Science Education* (pp. 321-327).

Sandusky, R. J., & Gasser, L. (2005, November). Negotiation and the coordination of information and activity in distributed software problem management. In *Proceedings of the 2005 international ACM SIGGROUP Conference on Supporting Group Work* (pp. 187-196).

Scott, G. R. (2009). *Teaching the team-authored text*. Riverside CA: University of California.

Simpson, C. (2017). Language, relationships and skills in mixed-nationality active learning classrooms. *Studies in Higher Education, 42(*4), 611-622.

Spangler, J. (2016). Chinese education models in a global age: myth or reality? In P. Chou & J, Spangler (Eds.), *Chinese Education Models in a Global Age* (pp. 337-354). Singapore: Springer.

Specht, P.H. (1985). Experiential learning-based vs. lecture-based discussion: The impact of degree of participation and student characteristics on comprehension and retention. *The Journal of Business Education, 60*(7), 283-287.

Stanley, P. (2011). Meeting in the middle? Intercultural adaptation in tertiary oral English in China. In L. Jin & M. Cortazzi (Eds.), *Researching Chinese Learners* (pp. 93-118). London: Palgrave Macmillan.

Sturner, K., Bishop, P., & Lenhart, S. (2017). Developing collaboration skills in team undergraduate research experiences. *Primus, 27*(3), 370-388.

Styers, M. L., Van Zandt, P. A., & Hayden, K. L. (2018). Active learning in flipped life science courses promotes development of critical thinking skills. *CBE—Life Sciences Education*, *17*(3), ar39, 1-13.

Theobald, E. J., Hill, M.J., Tran, E., Agrawal, S., Arroyo, E.N., Behling, S.,… & Freeman, S. (2020). Active learning narrows achievement gaps for underrepresented students in undergraduate science, technology, engineering, and math. *PNAS Proceedings of the National Academy of Sciences of the United States of America 117*(12).

Tie, H., & Umar, I. N. (2010). The impact of learning styles and instructional methods on students' recall and retention in programming education. *In Proceedings of the 18th International Conference on Computers in Education* (pp. 191-195).

Valenti, M. (2015). Beyond active learning: Transformation of the learning space. *EDUCAUSE Review, 50*(4), 31-38.

Van Slyke, C., Trimmer, K., & Kittner, M. (1999). Teaching teamwork in information systems courses. *Journal of Information Systems Education, 10*(3), 36-46.

Velasco, A.G., Agena, E.M., Orence, A., Gonzales, A.A., Beldia, R.A., & Laguador, J.M. (2015). Emotional elements on learning style preference of high and low performing junior marine transportation students. *International Journal of Multidisciplinary Academic Research, 3*(1), 1-8.

Wang, Y. (2021). Survey on deep multi-modal data analytics: Collaboration, rivalry, and fusion. *ACM Transactions on Multimedia Computing, Communications, and Applications (TOMM), 17(*1s), 1-25.

Wehrs, W. (2002). An assessment of the effectiveness of cooperative learning in introductory information systems. *Journal of Information Systems Education, 13*(1), 37-50.

Wheatley, M. (2006*). Leadership and the new science: Discovering order in a chaotic world.* San Francisco, CA: Berrett-Koehler Publishers.

Wolosin, R. J. (1975). Cognitive similarity and group laughter. *Journal of Personality and Social Psychology, 32*(3), 503.

Woods, D. M. (2020). Active Learning Using Debates in an IT Strategy Course. *Journal of Information Systems Education, 31*(1), 40.

Xiumei, S.H.I., & Jinying, W.A.N.G. (2011). Cultural distance between China and US across GLOBE model and Hofstede model. *International Business and Management*, *2*(1), 11-17.

Xu, D. (2019, May). Exploration on the operation mode of new foreign languages teaching platform based on PBL team cooperation. In *2019 5th International Conference on Humanities and Social Science Research (ICHSSR 2019)* (pp.122-126). Atlantis Press.

Zagal, J. P., Rick, J., & Hsi, I. (2006). Collaborative games: Lessons learned from board games. *Simulation & Gaming, 37*(1), 24-40.

Zhang, J., Li, H., Liu, Y., & Chen, Y. (2020). Orthographic facilitation in oral vocabulary learning: effects of language backgrounds and orthographic type. *Reading and Writing, 33*(1), 187-206

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