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HOW MATERIAL OBJECTS SHAPE STUDENT TEAM LEARNING PROCESSES

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We bring attention to the important, but previously overlooked, role that seemingly mundane material objects in management classrooms can have in student team learning processes. Specifically, we consider how material objects can shape team learning processes. We conducted an inductive qualitative study exploring how teams in an undergraduate strategy course worked together using two types of material objects: (a) whiteboards and (b) flip charts. Our findings indicate that how students interact with material objects when participating in team learning processes is influenced by four properties: (a) object location (static, mobile), (b) record-keeping (temporary, permanent), (c) form (whole, segmented), and (d) sensory awareness. These properties were found to afford student teams different possibilities for using the object which, in turn, shapes team learning processes through the level of agency over embodied learning, the nature of problem-solving behaviors (expansionist or reductionist), and approach to conceptual understanding (synergistic or discrete). The study contributes nuanced insight into the role of material objects in team learning processes and has pedagogical and practical implications for researchers and educators.

我们注意到在管理课程中,曾被忽视的教学设备对于学生小组学习的过程是非常重要的。所以:教学设备会如何影响小组学习过程?我们利用了两个教学设备:白板和活动挂图板,来探讨本科策略课程中的小组合作关系,并对此进行了归纳定量研究。我们的发现显示,在参与小组作业时,学生与教学设备的互动主要被四个方面影响:物品位置(静态、动态);时效性(暂时性、永久性);形态(整合性、分散性);和感官意识。通过使用教学设备,这些特点为学生小组提供了不同的可能性:将小组学习塑造得有自我控制感而不是单一具像化;问题解决行为性质,即扩展主义者或简化主义者;和概念理解方式(协同或离散)。此研究有助于深入了解教学设备在小组合作过程中的作用,同时对科研人员和教育工作者具有教育与实践意义。
关键字词:教学设备,团队学习,体验式学习,学习过程,本科教育,策略教学,定量研究,管理课程

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For management educators, material objects are "the physical stuff that we use while teaching" (Taylor & Statler, 2014: 590). These objects combine matter and form in ways that afford different possibilities for student action and interaction in our classrooms (Leonardi, 2011). Some material objects—like toys, clay, or spaghetti (Coff & Hatfield, 2003; Donovan & Fluegge-Woolf, 2015; McNeely, 1994; Roos & Victor, 2018; Taylor & Statler, 2014; Verzat, Byrne, & Fayolle, 2009)—can be categorized as "playful," which refers to objects used in an educational context to support learning through hands-on play. Other objects that are traditionally used to support learning in educational contexts can be categorized

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as "mundane," with whiteboards, desks, computer screens, and paper perhaps the most ubiquitous (Jarzabkowski, Burke, & Spee, 2015). Management educators use both playful and mundane material objects as they teach teamwork, problem-solving, critical thinking, and reflection activities in face-to-face classes (Adler, 2006; Irving, Wright, & Hibbert, 2019; Taylor & Ladkin, 2009). While the educator's imagination ultimately guides whether and how they choose to use playful material objects, mundane material objects are increasingly designed into the architecture of buildings to support collaboration (Irving, Ayoko, & Ashkanasy, 2019). Many university campuses have begun constructing "collaborative teaching spaces" furnished with material objects that afford more possibilities for team interactions and dialogue among students, such as multiple whiteboards and large round tables (Wright, Irving, Hibbert, & Greenfield, 2018). As Carlile, Langley, Nicolini, and Tsoukas (2013) reminded us, "to learn involves the material world (including the human body) as much as it involves the mind" (parentheses in original).

Although material objects are key aspects of the classroom for management educators, the relationships between material objects and team learning processes have received only limited empirical investigation by researchers. Consistent with the literature, we use the term "team learning" in this paper to refer to a group of three or more students working interdependently on a task to accomplish a mutual learning goal for summative assessment purposes, which can also be called "group learning" or "collaborative learning" (Rafferty, 2013). A small number of studies have explored how playful material objects like LEGO bricks and clay influence student engagement and creativity when working in teams (Roos & Victor, 2018; Taylor & Statler, 2014). Researchers have paid less attention to mundane material objects, with Vince's (2011) study of the positioning of chairs an exception. Deeper understanding of how material objects impact learning in management education is needed because, as the broader organizational literature highlights, "the materiality of an object favors, shapes, or invites, and at the same time constrains, a set of specific uses" (Zammuto, Griffith, Majchrzak, Dougherty, & Faraj, 2007: 752). This suggests student participation in team learning processes is being constrained and enabled by material objects, but a dearth of research means this remains hidden to management educators. Thus, there is "a need for a more theoretically based understanding of how materials can affect learning" (Taylor & Statler, 2014: 587). We address this need through a study that asks the question: "How do material objects shape team learning processes?"

To investigate our research question, we chose to focus our attention on mundane material objects used in the context of teaching strategy. Four factors guided this choice. First, scholars have recently called for more research into strategy education (Bell, Filatotchev, Karause, & Hitt, 2018). The strategy course, which is core to most contemporary undergraduate and postgraduate programs (Grant & Baden-Fuller, 2018), plays an essential role in developing students' knowledge of strategy as future business practitioners in an uncertain world (Adler, 2016). Second, student participation in team learning processes is a common feature of strategy courses. Educators must balance theoretically oriented learning with developing students' broader strategic management competencies in critical thinking, teamwork, communication, and problem-solving (Grant, 2008; Grant & Baden-Fuller, 2018; Priem, 2018; Wright & Gilmore, 2012). Third, educators have designed team-based strategy analysis and formulation exercises that incorporate playful material objects, such as LEGO bricks (Roos & Victor, 1999, 2018) and Tinkertoys (Coff & Hatfield, 2003). Educators also use mundane material objects in the strategy classroom to teach strategy theories and tools, which students apply to analyze a firm's external environment, internal organization, and competitive advantage (Barney & Mackey, 2018; Greiner, Bhambri, & Cummings, 2003). While some research has been conducted into playful material objects, little is known about how mundane objects impact team learning processes in strategy courses. Fourth, researchers in the strategy-as-practice literature have found that how managers' strategize—both in organizations and in strategy workshops—is affected by mundane material objects, including desks and room layout, PowerPoint slides, computer screens, whiteboards, flip charts, pens, and notepads (Jarratt & Stiles, 2010; Jarzabkowski et al., 2015; Kaplan, 2011; Paroutis, Franco, & Papadopoulos, 2015). We infer from this research that mundane material objects are also likely to play an important role in shaping how students participate in team learning processes when undertaking strategic analyses in the strategy classroom.

Together, these four factors informed our decision to explore our research question through a qualitative interpretive study of an undergraduate capstone strategy course. Collecting data as students were

taught in a collaborative teaching space at an Australian university, we examined team learning processes associated with two mundane material objects: (a) whiteboards and (b) paper flip charts. Our findings indicate that how students interact with material objects when participating in team learning processes is influenced by four properties: (a) object location (static, mobile), (b) record-keeping (temporary, permanent), (c) form (whole, segmented), and (d) sensory awareness. These properties afford student teams different possibilities for using the object, which, in turn, shapes team learning processes through the level of agency over embodied learning, the nature of problem-solving behaviors (expansionist or reductionist), and approach to conceptual understanding (synergistic or discrete).

These findings make three contributions to the literature in management education. First, our findings contribute to the burgeoning literature on student team learning by opening up new insight into how team learning processes are constrained and enabled by the distinctive properties of material objects that teams are given to work with. Second, our findings offer a counter to the attention on playful objects in the management education literature by shining light on the important but previously hidden ways that mundane material objects can foster team problem-solving and conceptual understanding. Third, our findings contribute to ongoing scholarly debates about how to teach strategy courses to build students' competencies and skills in applying strategy theories and tools as future business practitioners (Grant, 2008; Grant & Baden-Fuller, 2018; Priem, 2018).

In addition to these contributions to the management education literature, our findings about the use of mundane material objects in face-to-face classes have practical implications that are timely and important. Although advances in digital technology and the COVID-19 pandemic have accelerated a move to online learning, face-to-face learning in the social and physical environment of a classroom remains a cornerstone of the university experience (Redpath, 2012; Whitaker, Randolph, & Ireland, 2016). Face-to-face learning offers benefits for students as a cognitive, behavioral, and collaborative experience that cannot be easily replicated with online learning (Arbaugh, 2014; Cheng & Chau, 2016; Irving et al., 2019; Vince, 2011). Thus, we conjecture that, as universities move through and beyond the COVID-19 pandemic, there will be a renewed commitment to complementing online learning with a face-to-face classroom experience that fosters, among other things, participation in team learning processes. By opening up more nuanced insight into the ways material objects can impact these processes, our findings guide management educators to design more effective learning experiences and inform university administrators about how to furnish and resource better classrooms.

THEORETICAL BACKGROUND

In this section, we present theoretical insights from prior literature that informed our study. First, we sketch out broad themes from the literature in management education that examines student learning processes in teams. Our purpose is to highlight insights pertinent to our research question rather than present a comprehensive review of the burgeoning literature on team learning in organizations and in education (Edmondson, Dillon, & Roloff, 2007; Williams, Irving, Wright, & Middleton, 2020). Second, we consider the literature on material objects used in student learning and the paucity of empirical research conducted on this topic in management education.

Student Learning in Teams

Team learning has become a popular approach in management education practice (Briggs, Workman, & York, 2013), fueling theory and research that explores how students learn in teams (Irving et al., 2019; Morgan & Stewart, 2019). One well-established theory posits that learning is an experiential process, in which a learner has a concrete experience which is reflected on, conceptualized and tested out for application in a future situation, creating new experiences (Kolb, 1984). Participating in teams can enhance this experiential learning process by allowing students to socially interact and share experiences, engage in reflective dialogue, and challenge the thinking of fellow team members as they apply and test out concepts and theories (Cajiao & Burke, 2016; Kolb & Kolb, 2005). Learning occurs as team members "focus on mutually acquired learning goals and the achievement of group tasks … for summative assessment purposes" (Rafferty, 2013: 626). Collaborative learning experiences can enable students to complete complex tasks that exceed their current skill level (Schippers, 2014), insightfully apply course theory and concepts to practice (Kalliath & Laiken, 2006; Whetten, 2007; Wright & Gilmore, 2012), and improve critical thinking and higher-level synthesis of content knowledge

(Hernandez, 2002; Ramsden, 2003; Wright, Irving, Hibbert, & Greenfield, 2018). More creative and integrative problem-solving can unfold when students work together to recognize and conceptualize problems, generate alternatives, evaluate alternatives, and advocate for a chosen alternative (Goltz, Hiatapelto, Reinsch, & Tyrell, 2008). In addition to content-related learning, participating in teams can help students learn generic teamwork and communication skills (Hansen, 2006).

However, research shows there are challenges to student learning through participation in teams (Bacon & Stewart, 2019). Students may engage in non-cooperative behaviors if they do not view the assigned team task as a shared goal that benefits all members (Bacon, 2005), do not feel accountability for team outputs (Slavin, 1988), or do not believe their contribution is valued (Jassawalla, Sashittal, & Malshe, 2009). Competition, distrust, and self-interest can emerge (Rafferty, 2013), inhibiting "psychological safety," which is "a shared belief held by members of a team that the team is safe for interpersonal risk taking" (Edmondson, 1999: 350). Conflict over perceived incompatibilities of ideas, opinions, and viewpoints can bring a team into dispute (O'Neill, Hoffart, McLarnon, Woodley, Eggermont, & Brennan, 2017). At the other extreme, highly cohesive student teams can be afflicted by groupthink and reach agreement too quickly with little debate when solving problems (Bacon, Stewart, & Silver, 1999). Challenges also arise when teams perform complex tasks and divide the workload into multiple individual tasks to increase efficiency (Slavin, 1988), limiting individual member's exposure to and learning from all aspects of the team task (Ashraf, 2004; Bacon, 2005). Less conscientious students may practice "social loafing," expending lower effort working in a team than they do when working alone (Schippers, 2014; Wilcoxson, 2006).

Educators use pedagogical methods to try to reduce these challenges and harness the learning benefits of student participation in teams (Bacon & Stewart, 2019; Rafferty, 2013; Ramsden, 2003). Methods can relate to team composition (Wilcoxson, 2006), design of team tasks and assignments (Ashraf, 2004; Bacon, 2005; Hansen, 2006), incentivizing and assessing individual contributions to team performance (Ferrante, Green, & Forster, 2006; Johnston & Miles, 2004; Michaelsen, Knight, & Fink, 2004; Sharp, 2006), and preparing students to work in and lead teams (Chen, Donahue, & Klimoski, 2004; Snyder, 2009). For example, educators can establish clear team goals and feedback for continuous learning (London & Sessa, 2006), develop role definitions for individual team members (Erhardt, 2011), and offer coaching and formative feedback for "just-in-time" learning (Bolton, 1999). They can also assign students to teams or allow self-selection to leverage diverse skills, perspectives, and experiences among team members (Aggarwal & Williams Wooley, 2019; Bacon et al., 1999; Chapman, Meuter, Toy, & Wright, 2006). Tasks can be designed to guide discursive relationships between peers and faculty (Cajiao & Burke, 2016) and to develop team-based knowledge work (Erhardt, 2011). Students can receive training to develop their teamwork knowledge and competencies (Chen et al., 2004; Jassawalla et al., 2009) as well as training in constructive controversy and reflexivity to support information sharing and problem-solving (O'Neill et al., 2017). Students can be asked to develop team charters (Hillier & Dunn-Jensen, 2012), and to evaluate contributions of themselves and peers to the team (Brutus & Donia, 2010; Brutus, Donia, & Ronen, 2013; Ohland et al., 2012).

A recent review article by Morgan and Stewart (2019) concluded that, despite an abundance of research on student teams, management educators continue to find that their teaching approaches are not always as effective as they would like them to be in supporting student participation in learning processes. Thus, there is an ongoing need for research to deepen understanding of the pedagogical techniques that affect the student learning experience and behaviors in teams (Bacon & Stewart, 2019). We contend that the material objects with which student teams interact during learning processes is an area worthy of inquiry, echoing calls for more explicit research attention to improve pedagogic theory and practice associated with material objects in management education (Taylor & Statler, 2014).

Material Objects and Student Learning

In recent years, management educators have begun experimenting with material objects as a pedagogical technique to counter some of the challenges of student teams and foster content-related learning and general teamwork learning in the classroom (Donovan & Fluegge-Woolf, 2015). Many of these material objects can be classified as playful in their form or use. For example, playing with Tinkertoys has been used to illustrate concepts such as the functions of management (McNeely, 1994), job characteristics (Smrt & Nelson, 2012), strategy (Coff & Hatfield, 2003), and systems theory (Trefry, 2002), while LEGO has been used to demonstrate job design and strategy (Donovan & Fluegge-Woolf, 2015; Roos

& Victor, 1999; Taylor & Statler, 2014). In other instances, the objects involve common stationery items being used in playful ways, such as exercises in which teams use paper and tape to build a skyscraper (Sheehan, 2006). Studies suggest playful objects are successful in facilitating student learning because they make abstract course concepts clearer and more visual and concrete (Coff & Hatfield, 2003; Smrt & Nelson, 2012), leverage play for enabling creativity (Roos & Victor, 2018), and actively engage students in the learning process (McNeely, 1994). Playful objects also enhance sensory awareness and emotional engagement (Taylor & Statler, 2014), especially arts-based objects like paint (Adler, 2006; Maranville, 2011), clay (Taylor & Statler, 2014), or creating a collage (Colakoglu & Littlefield, 2011). Learning activities involving finger puppets (Kempster, Turner, Heneberry, Stead, & Elliott, 2015), toy construction sets (McNeely, 1994), spaghetti (Verzat et al., 2009), and Play-Doh (Trefry, 2002) also engage the senses through unexpected objects being brought into classrooms for fun "hands-on" learning using touch and feel.

While management educators have undertaken descriptive evaluations of these playful material objects, systematic empirical research of how educator choices of material objects influence learning is limited. In particular, scant attention has been paid to the impacts that material objects that are less playful and more mundane have on learning in student teams. Although not as novel or imaginative as playing with children's toys, art supplies, or spaghetti (Verzat et al., 2009), business school classrooms are furnished with whiteboards, flip charts, desks, and other objects that matter for what students feel and do when they learn in teams, albeit in less obvious ways. Experiential learning "involves the integrated functioning of the total person—thinking, feeling, perceiving, and behaving" (Kolb & Kolb, 2005: 194) and links a person's mind and the body so that learning has emotional and embodied aspects alongside cognitive and behavioral aspects (Cunliffe & Coupland, 2012; Hoover, Giambatista, Sorenson, & Bommer, 2012; Wright, Hibbert, Strong, & Edwards, 2018). A study by Tomkins and Ulus (2015) showed how mundane material objects help to integrate movement of bodies, ideas, and emotions in experiential learning, with a "low block" generating a "campfire discussion" in the classroom. Further highlighting the salience of mundane classroom objects for experiential learning, Vince's (2011) study found that students feel emotions and power relations according to how their chairs are positioned in the management classroom. However, studies such as these are rare. Material objects—the playful and especially the mundane—remain underexamined in management education research. As Taylor and Statler (2014: 599) lament, "we lack formal theory that integrates materiality into pedagogy in an actionable way."

The broader literature on sociomateriality offers some starting points for conceptualizing the relationship between material objects and student learning processes (Boxenbaum, Jones, Meyer, & Svejenova, 2018; Orlikowski, 2007). An important concept is "material affordances," which enable and constrain possibilities and uses for action (Zammuto et al., 2007: 752). Research conducted in organizations highlights the affordances of some material objects that are also commonplace in management education. PowerPoint slides, for example, support knowledge production by affording teams the potential to collect, represent, share, and edit ideas in meetings (Kaplan, 2011). Pictures, maps, data packs, spreadsheets, and graphs afford both knowledge abstraction and substitution (Jarzabkowski, Spee, & Smets, 2013). In a study of an organizational workshop, a software tool on a public computer screen was used to create, share, and reproduce knowledge among participants through affordances that made strategic issues visible, tangible, editable, and traceable (Paroutis et al., 2015). In a different workshop, managers evaluated two strategic options on flip charts while the chief executive worked to ensure acceptance of her preferred option by controlling the public display of the flip charts on the walls of the room (Whittington, Molloy, Mayer, & Smith, 2006). Other research in organizations brings material objects together with speech and the human body, showing how collaborative work can be accomplished when members of management teams focus on the same material objects in mutual work spaces (Jarzabkowski et al., 2013).

A key implication of these studies in organizational research for management education is that mundane material objects are likely to shape student team learning experiences through the affordances they provide as possibilities for using the object to think, feel, and do. Given the paucity of empirical research into material objects and student team learning processes in management education (Taylor & Statler, 2014), we sought to clarify and refine understanding. To this end, we conducted a study of how material objects shape student team learning processes, with a particular focus on whiteboards and flip charts as mundane material objects used in teaching strategy.

METHODS

Research Setting

Our approach to the research is framed within an "interpretive perspective," which believes in multiple interpretations of reality and does not privilege a single truth (Lincoln & Guba, 2000). This meant we designed a research study that addressed our research question by seeking to understand students' subjective experiences as they worked together in teams and interacted with and made sense of material objects. We chose to focus our study, which was conducted at a university in Australia prior to the COVID-19 pandemic, on mundane material objects associated with the social and physical environment of the classroom in a collaborative teaching building. Our research design drew upon qualitative methods to collect and analyze empirical material associated with students working with two types of material objects: whiteboards and flip charts.

The research was conducted in an undergraduate strategy course in the AACSB-accredited business management program at a large university in a major Australian city. The course is taught over a 13-week semester, is compulsory for all students, and is generally taken by students in the final year of their program of study. Student enrolments are typically in excess of 400 students each semester, comprising 47% males and 53% females, and 65% domestic students and 35% international students. The median age of students enrolled in the course during data collection was 22 years old. Each cohort is taught in multiple sections of around 90 to 100 students, who attend an interactive three-hour class on campus each week. Each class is taught by the same course instructor supported by teaching assistants. A major component of the course assessment each semester takes place in four of these classes, when students work in teams to analyze the strategies of case study companies. Known in the course as "management team meetings," these activities meet the accepted definitions of "team learning processes" from the management education literature in that they involve mutual learning goals to be achieved by students working in class together in groups for summative assessment purposes (Rafferty, 2013). Students' best marks from three management team meetings are counted toward their final course grade (weighted at 30%, comprising $3 \times 5\%$ individual preparation and $3 \times 5\%$ team participation and quality of outputs).

Prior to a class run as a management team meeting, students prepare individually by reading the annual report of the particular case company assigned for that week (different case company for each meeting) and applying the following conceptual frameworks commonly taught in undergraduate and postgraduate strategy courses: PESTLE analysis, Porter's "five forces" model, and the VRIN framework (Jarratt & Stiles, 2010; Wright, Paroutis, & Blettner, 2013). A PESTLE analysis evaluates opportunities and threats in a firm's political, economic, sociocultural, technological, legal, and environmental conditions (Thomas, 1980). Porter's five forces model, based on the structure–conduct–performance framework, analyses the five forces that shape competition within an industry to inform a firm's competitive positioning and potential economic profit (Porter, 2008). The VRIN (corresponding to "valuable," "rare," "imperfectly imitable," and "not substitutable") framework, underpinned by the resource-based view of the firm, analyses the internal resources and capabilities that could provide a source of competitive advantage as the basis for a value-creating strategy (Barney, 1991). When students attend their class in the collaborative teaching space, they work together in groups as the "management team" of the case company. As the class unfolds over three hours of facilitated guidance in the hands of the course instructor and supported by teaching assistants, the student members of each management team compare their individual preparatory work using the strategy tools, try to synthesize their insights, identify strategic problems and opportunities, and evaluate and recommend alternative courses of action.

Given this was a capstone strategy course, students were assigned to teams by the instructor to ensure that team composition was diverse across business majors. At the start of the semester, the course instructor divided each class of 90 to 100 students into 12 teams comprising seven to nine students in each "management team." Students were permanently assigned to these teams and remained in the same team for the semester. The instructor allocated teams to use a particular material object in each class and teams were rotated across the material objects in different meetings. Instructor allocation ensured that every student team was progressively exposed to learning experiences in which they used a whiteboard *and* sheets of flip chart paper over the four management team meetings.

During each management team meeting, teams used their assigned material objects to complete tasks in three phases interspersed with whole-class debriefs by the course instructor. In the first phase, students discussed their individual preparation to

develop a team analysis of the case company, with their consensus application of the various strategy tools recorded on their allocated whiteboard or sheets of flip chart paper (task 1 = team analysis). In the second phase, teams were asked to combine relevant course theory with insights gained from their initial analysis to discuss, and evaluate on the whiteboard or paper, alternative courses of action for the company (task 2 = best course of action). In the final phase, teams developed strategic recommendations for the company, recorded on the whiteboard or paper (task 3 = future recommendations). At the end of each phase, a teaching assistant took a photograph of the whiteboard or the flip chart paper as a partial submission of the team's output for summative assessment purposes. The three partial outputs were combined into a single file at the end of class and uploaded as the official team output for grading.

Sampling and Data Collection

We collected multiple sources of data. Four types of data were collected across two semesters: (a) naturalistic observations of management team meetings, (b) photographs of material artifacts, (c) direct questioning of students and facilitators, and (d) documents related to the course. The data collection process for each data type is next explained in detail, along with the sampling strategy for each.

Observations. Our primary data source was in-class observations, which allowed real-time and in-context tracking of students interacting with one another and the whiteboards and flip chart paper as they worked with the strategy tools during management team meetings. In-class observations were considered appropriate, given Jarzabkowski and Kaplan's (2015: 552) recommendation that "there is little substitute for spending time in the field watching [because] … the actual use of [strategy] tools is emergent, requiring the researcher to be in the right context at the right time to observe what unfolds." The first author, who is an independent researcher not associated with course teaching, spent a total of 110 hours over two semesters collecting observational data.

The sampling strategy for these in-class observations unfolded over two semesters. In Semester 1, in 2019, ethics approval was granted to observe teams as they used whiteboards and flip charts in the fourth management team meeting for the course in Teaching Week 7. Each student team had experience working together in three prior meetings using both whiteboards and flip charts. The first author observed teams using material objects in four classes, with seven teams using a whiteboard and five teams using flip chart paper in each class. The author returned to class to observe in Teaching Week 8, which was a non-assessable week, to collect "reflection-on-action" comments (see Schön, 1983) from students recorded in a field diary. A total of 21 hours of in-class observations were conducted in Semester 1. In Semester 2, 2019, the first author conducted 89 hours of in-class observations of assessable management team meetings (five classes comprising seven to nine teams per class per week for four weeks) and additional observations of teams in practice weeks.

Within each class, the first author balanced his attention across teams working on whiteboards and flip charts. He recorded observations following Emerson's (2004) naturalistic approach, describing "what I see and hear" in the social setting of the classroom rather than following a predetermined theoretical template. He noted "key incidents" involving a team's use of the whiteboard or flip chart that struck him as interesting (Emerson, 2004). Facilitators also pointed out relevant activities of different teams. Observations were recorded as handwritten field notes and typed up within 24 hours.

Photographs. Ethics approval was granted in Semester 2 to augment the written field notes of in-class observations with photographs as a form of visual data representation (Meyer, Höllerer, Jancsary, & Leeuwen, 2013) A total of 484 photographs were taken of (a) students using whiteboards and flip charts during management team meetings, and (b) the strategy tools (PESTEL, five forces, and VRIN) and other strategic decisions that teams wrote on whiteboards and flip charts. Photographs provided a less restrictive and more accurate record of the material objects (Ray & Smith, 2012), minimized recall bias from observations (Collier & Collier, 1986), and allowed detailed illustrations of the use of material objects and strategy tools as "stuff" involved in team learning processes of doing strategy (Jarzabkowski et al., 2013). Adopting the method of researcher-only photograph production (Ray & Smith, 2012), the first author took photographs when elements in the empirical context struck him as theoretically salient in addressing the research question.

Reflective comments and interviews. Primary data were collected from students and facilitators through direct questioning. Given the exploratory nature of the research, direct questioning was considered appropriate to unpack the impact of the material objects on team processes and capture the

variations in student learning experiences (Belk, Fischer, & Kozinets, 2013; Flick, 2002). Direct questioning generates more relevant and personal accounts (Guest, Namey, Taylor, Eley, & McKenna, 2017), offering different perspectives on the role of material objects on team learning than could be captured in observations and photographs. Additionally, direct questioning would allow research participants to give voice to their own lived experiences and express their "own truths" (Corley, 2015; Wright, Middleton, Hibbert, & Brazil, 2020), thus aligning with our paradigmatic stance. Direct questioning took two forms.

First, during in-class observations, students were informally questioned about their learning experiences with the material objects during breaks in the management team meetings. While depth interviews or focus groups would have generated richer personal accounts (Flick, 2002; Guest et al., 2017), ethical considerations meant it was not possible to undertake this form of data collection until after students had completed the course and received their final grades. This time delay between when a student participated in the assessable management team meetings and when they were asked in an interview or focus group about their experiences of material artifacts in those meetings could generate retrospective biases (Golden, 1992). Given this, we elected to question students about their comparative experiences of using whiteboards and flip charts in the first class immediately after the management team meetings in Semester 1 and in real time in Semester 2, during breaks in the seminar as the first author undertook observations. Individual student responses were recorded in the field diary as "reflection-on-action" comments (see Schön, 1983). Because the purpose was to gain quick insight into student's experience rather than to generate a probability sample to draw statistical inferences, a convenience sampling strategy was used to identify participants (Corbin & Strauss, 2008; Robinson, 2014). In total, 61 students provided reflective comments, comprising 23 students and 38 students in Semesters 1 and 2 respectively.

Second, the first author conducted formal interviews with nine teaching assistants involved in teaching the course as in-class facilitators. Facilitators were not compelled to participate in an interview, were assured of confidentiality, and gave informed consent to be interviewed. The interviewee sample comprised seven males and two females, four of whom had completed or were completing PhD qualifications. Facilitation experience varied from "first time" (3), "one or two years" (4), and "three or more years" (2). Interviews were semi-structured, with questions exploring facilitator perceptions of team learning behaviors and the impact of the materiality of whiteboards and flip charts. Interviews lasted between 30 and 60 minutes and were digitally recorded and transcribed. In the presentation of the findings, quotes from these students and facilitators are identified by alphanumeric codes S1 to S62 and F1 to F9 respectively.

Documents. The final source of data we collected was documents. We collected all relevant course materials, including the course profile, textbook, lesson plans, and activities associated with management team meetings and assessment rubrics. Following prior research, we drew upon these documents as useful background information about the course context but did not code them in our data analysis (Wright, Zammuto, & Liesch, 2017). Table 1 presents a summary of the four types of data, the amount of each data type, and how each type was used in analysis.

Data Analysis

Our analysis followed procedures for inductive theory building from qualitative data (Corbin & Strauss, 2008). These procedures include iteration between data collection and analysis (Gioia, Corley, & Hamilton, 2013), constant comparison within and across texts to develop theoretical codes that are empirically grounded in the data (Suddaby, 2006), and continuation until theoretical saturation is reached and no new themes emerge (Corbin & Strauss, 2008). Data were analyzed over three stages.

Analysis stage 1. We began our analysis as soon as the first round of observational data and student reflective comments were collected in Semester 1. The purpose of this first stage of analysis was to gain initial familiarization with the data set by developing preliminary insights into the different ways that the whiteboard and flip chart might be influencing team learning processes. After reading each field note multiple times, we coded segments of text by comparing iteratively within and across the text for patterns of similarities and differences (Corbin & Strauss, 2008). Guided by our research question, we identified three broad properties of material objects that appeared to be relevant to the team learning experience. We tentatively labeled these properties as "spatial," "transient," and "visual" since they reflected the space available for writing up learning activities, the ability to erase writing, and the "look"

TABLE 1
Description of Data

Data types	Amount of data	Use in analysis
Observations	21 hours of in-class observations in Semester 1 producing 35 single-spaced pages of field notes	Coding to identify the properties of a material object that have an impact on team learning (Analysis stage 1)
	89 hours of in-class observations in Semester 2 producing 85 single-spaced pages of field notes	Comparing within and across the field notes for properties of material objects (Analysis stage 2)
Photographs	484 photographs of student interactions with whiteboard and flip charts	Deepening understanding of how each property influences certain aspects of team learning processes (Analysis stage 3)
Reflective comments and interviews	61 students provided reflective comments recorded in a field diary during in-class observations (23 in Semester 1, 38 in Semester 2)	Coding to identify the properties of a material object that have an impact on team learning processes (Analysis stage 1)
	9 facilitators participated in formal in-depth interviews producing 115 single-spaced pages of interview transcripts	Verifying and elaborating understanding of how each property influenced certain aspects of team learning processes (Analysis stage 3)
Documents	Course materials, textbook, learning activities and lesson plans, company annual reports, and marking rubrics associated with management team meetings	Provided background information about the undergraduate strategy course but not coded during analysis

of the object respectively. Our emergent understanding of the spatial, transient, and visual properties of whiteboards and flip charts as material objects informed the first author's approach when he returned to the classroom for a second round of observational data collection in Semester 2 and when he interviewed facilitators.

Analysis stage 2. The second stage of data analysis overlapped with the second round of data collection. Guided by the literature on material affordances (Zammuto et al., 2007), we focused initially on analyzing the field notes and student reflective comments from Semester 2. As we read and re-read this new data, we refined and deepened our tentative understanding of the properties of whiteboards and flip charts that had emerged from the previous stage of analysis. We were struck by how the spatial property of whiteboards and flip charts could be further broken down into whether the object existed as a whole form or in parts, and whether the object stayed in one location or could be moved. We re-labeled the first spatial property as "form" and categorized the whiteboard as being of "whole form" and the flip chart as being of "segmented form." We re-labeled the second spatial property as "location" and categorized the whiteboard as having a "static location" and the flip chart as having a "mobile location."

As we reviewed the new data, it occurred to us that what we had previously identified as an object's transient property was fundamentally about keeping a written record. Given this, we re-labeled the transient property as "record-keeping" and categorized the whiteboard as providing "temporary record-keeping" and the flip chart as providing "permanent record-keeping." We also re-labeled the visual property after we noticed that in addition to the look of an object, some students had sensory experiences of a whiteboard or flip chart based on how it felt to touch and what sounds it made when being written on or torn. Drawing on the sensemaking and learning literature (de Rond, Holeman, & Howard-Grenville, 2019; Gartner, 2013; Taylor & Statler, 2014), we re-labeled this property as "sensation," to better reflect the breadth of sights, sounds, and touch that students might sense when using a whiteboard or flip chart. We were struck by how this property of sensations was qualitatively different to the object properties of location, form, and record-keeping. Unlike these other three properties, teams did not seem to experience the sensory property in opposing categories for whiteboards and flip charts.

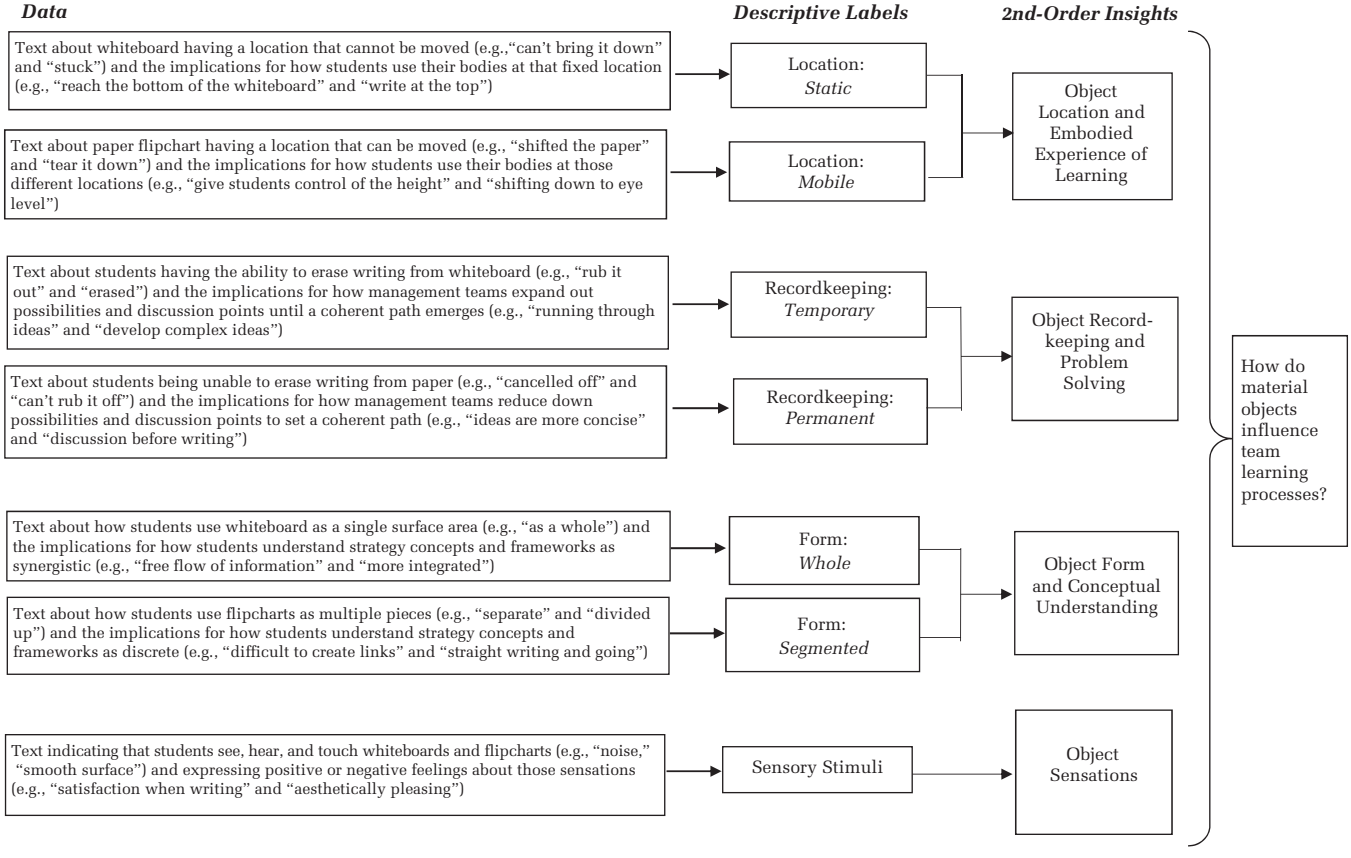
Having identified these four major properties, the first author coded all of the Semester 2 field notes and student reflective comments into these descriptive categories before revisiting and re-coding the

Semester 1 data. At the end of this stage of data analysis, a confirmatory check was conducted within the research team to ensure text segments were coded to the most relevant object properties.

Analysis stage 3. In this final stage of analysis, we sought to understand how the four properties of location, record-keeping, form, and sensation influenced student team learning processes. Continuing to focus on the field notes and reflective comments for Semester 1 and Semester 2, we compared within and across the data subsets that had been coded into each dimension within each property category. Our analysis suggested that static and mobile locations predominantly influenced team learning through how team members sensed and physically moved their bodies to coordinate with each other and the material object. Informed by the process of enactive lived embodiment at the intersection of the sociomateriality and learning literatures (Cunliffe & Coupland, 2012; Gartner, 2013; Gherardi, 2001), we labeled this particular influence in the team learning process as "embodied experience." Permanent and temporary record-keeping appeared to influence team "problem-solving" in ways that we labeled as either "expansionist" or "reductionist," consistent with the literature (Goltz et al., 2008). Property form influenced a team's approach to "conceptual understanding" in ways that we labeled as "synergistic" or "discrete," as described in the learning literature (Hernandez, 2002; Ramsden, 2003). Property sensation did not appear to have a high level of impact on the team learning processes, although some individual students reported "sensory awareness" of material objects during their learning experience.

Finally, we turned to the photograph data and the facilitator interviews to verify and elaborate our emergent understanding of the second-order relationships between an object property and team learning. This coding confirmed and deepened our theorizing of how each property has a distinctive influence on specific aspects of team learning processes. Figure 1 presents the data structure of the

FIGURE 1
Data Structure of the Coding



coding through which the second-order theoretical relationships between object properties and learning emerged. We present representative text data and photographic data illustrating how the four properties of material objects influence team learning processes in Tables 2 and 3.

FINDINGS

This section presents the findings that emerged from the analysis of how student teams interacted with the mundane material objects of whiteboards and flip chart paper during in-class team learning processes in a strategy course. The findings reveal that these material objects influence team learning processes through four properties: (a) object location, (b) object record-keeping, (c) object form, and (d) object sensation. For the purpose of clarity, each property and its dimensions are presented as analytically distinct, and the most significant influence on team learning processes is reported. We follow the common approach in the sociomateriality literature (Jarzabkowski & Kaplan, 2015; Middleton, Irving, & Wright, 2021; Whittington et al., 2006) of illustrating these properties through vignettes.

Object Location and Team Learning Processes

The first object property that impacted team learning processes was *location*. Whiteboards were fixed to the wall and were not able to be moved by teams. In contrast, sheets of flip chart paper could be attached and re-attached to the walls in different locations according to student needs. Our data analysis shows that static and mobile locations primarily influenced team learning experiences through embodiment.

Static location and embodied learning. The whiteboard's static location reduced a student's agency over how they used their own body when they physically interacted with other students and the material object during team learning processes, as illustrated in this vignette:

> A team of nine students stands beside each other at the whiteboard. A scribe starts writing on the left side of the whiteboard as three other students stand around her and call out ideas about environmental opportunities and threats facing the case study company. The scribe stands on tiptoe and reaches up to write high on the whiteboard, contorting her body as she writes and progressively crouching down to write at the bottom. A white space remains at the top of the whiteboard where she is too short to reach. At the right side of the whiteboard, a second scribe, who is extremely tall, writes an industry analysis along the top edge of the whiteboard with the help of four students standing beside him juggling their laptops on their forearms. The tall scribe is forced to bend down to write on the lower-right quadrant of the whiteboard. He eventually kneels down, maneuvers around with both knees on the floor, and completes the write up of the industry analysis along the bottom of the whiteboard. (Field notes)

The vignette shows how the height of the whiteboard's attachment to the wall imposed physical constraints on students who acted as scribes during team tasks, with individuals of short or tall stature struggling to write at the top and bottom of the whiteboard respectively. This pattern was evident in both the real-time observational field notes and the photographs, which show students constrained by their own height and arm span when writing. Comments included "it sucks to be trying to reach up on the whiteboard," "[the whiteboard will] waste space especially if you're not tall enough to write at the top," and "my arm is very sore [after writing on the whiteboard]." In addition, the whiteboard's static location dictated how students positioned their bodies as a collective, forcing them to stand close together across the front of the whiteboard to access it during learning tasks. Field notes and photographs indicated that students tended to "array horizontally" (Field notes) and in large semi-circles facing the whiteboard. A student explained that, "collaborating on the whiteboard, you've only got a semi-circle" (S37) as a way of arranging people who are contributing ideas but not actively writing on the whiteboard. Overall, the data show that the static whiteboard leads to individual team members feeling they have less agency over their embodied learning experience within the team because "they have to fit to where the medium is" (F2). As a student said, "we are kind of cramped and condensed in one spot, and obviously stuck" (S38).

Mobile location and embodied learning. In contrast to the static location of the whiteboard, the mobile location of the flip chart paper sheets provided students with more agency over their own body as they physically interacted with people and objects when performing team tasks, as illustrated in this vignette:

> A team of seven students walks up to two sheets of paper pasted side by side on the wall. A student detaches the left-sided sheet, repositions it a greater distance away from the right-sided sheet, and writes "general environment" at the top of paper. Three students cluster behind him, holding his laptop and

TABLE 2
Representative Text Data on Material Objects and Team Learning

Property	Representative data
Static location: Less embodied agency	"If someone's really short, they might have a problem writing on the whiteboard." (F2) "With the whiteboard, it's very set." (F5) "Have to stand there and tiptoe to reach the top of the whiteboard." (S29) The scribe kneels as she writes at the bottom half of the whiteboard. (Field notes) Scribe 2, who is writing halfway down the whiteboard, is already kneeling down so that he can write slightly above eye-level. (Field notes)
Mobile location: More embodied agency	"[They can] be proactive … and take a piece of paper, tear it out, and stick it up." (F6) "I prefer the paper flip chart because you can move it around. Like, you can write on top, write below … Some people will be taller, some people are shorter." (S45) "Whereas, on the paper flip chart, we can take it away and throw it on another wall and we can bring it back. Without all of us being stuck and bunched together." (S38) The scribe writes a PESTEL analysis in the second half of the paper, tears it out, and pastes it higher to write. (Field notes) The team rearranges their paper sheets so they are side by side. (Field notes)
Temporary record-keeping: Expansionist problem-solving	"You can wipe it out and start again. You can put your thoughts up that maybe aren't the best, but you are just running through ideas … they actually put up their ideas here on the whiteboard and pick out the best ones." (F8) "We have more flexibility in terms of the whiteboard … A lot of times, where we are putting stuff down, and if we want [to write] something else, we rub it out and put something else in. It gets a little better." (S27) "It's a lot easier where you can just rub stuff off, unlike the butcher's paper. And it's also easier to write something on the whiteboard to help you visualize something and then rub it off and write your ideas." (S56) The team begins by writing their thoughts on the whiteboard without following any specific structure. They are just throwing their ideas on the whiteboard and are mapping out their thought process. They discuss and develop their strategic recommendations on the surrounding information that was written around the whiteboard. (Field notes)
Permanent record-keeping: Reductionist problem-solving	"You write something, you can cross it out, but you can't rub it out. So you can't experiment with ideas on the flip chart." (F1) "Way more cautious on a flip chart than they are on a whiteboard … tend to discuss things more." (F6) "And the reminder [of your past ideas] is still there. So, when you're reading [what's already written on the paper], you'll be thinking, 'Oh, that's not right? Oh, is it right?' Whereas, on the whiteboard, once it's gone, you don't think about it anymore, so you won't get confused with it." (S39) "We are more conscious, like, where you can write. When you are writing on the flip chart, you can't backtrack." (S60)
Whole form: Synergistic understanding	"One [subgroup] will look at the general environment PESTEL analysis, the other will look at the industry analysis. And they'll, within the smaller teams, work through those separately. And then, when they get stuck or when they'd like input from the other members, they autonomously ask each other 'Do you guys have any insights on? Did you have anything to add?'" (F9) "They actually put up their ideas on the whiteboard and pick out the best ones and joined a couple together, which I don't think they would have got on the paper." (F7) "Everyone is doing the same thing. It wasn't everyone doing the different activity on the same board." (S24) The facilitator mentioned that "It's easier for the team to be more collaborative with the whiteboard ... work on three analyses with three writers ... can see across the analyses so it's more collaborative and the thinking is more integrated." (Field notes) When the team develops their strategic recommendation, one student keeps looking across from the analyses written on the left side of the whiteboard to the right side where the scribe is writing. The student suggests how the points of analysis on the left can be integrated into a well-justified recommendation. (Field notes)
Segmented form: Discrete understanding	"[Students] just seem to focus on that single piece of paper they were currently working on." (F9)

TABLE 2
(Continued)

Property	Representative data
	"You're doing different parts [of your strategic analysis] on different pieces of paper—it creates some kind of divide within the team." (S24)
	The VRIN is written on one sheet of paper while the resources and capabilities are written on another sheet. When conducting the VRIN test, the team made no reference to the resource and capabilities sheet. (Field notes)
	Finished sheets were dumped at the side in a messy manner, and students made no reference to what was written previously in their analysis. (Field notes)
Sensation	The facilitators detach paper sheets from the walls and rip new sheets off the flip chart packet to attach to the walls for the second activity. The noise is very loud and distracting. Several facilitators and the course coordinator comment on this to me later. A facilitator says, "I find the ripping noise distracting during the debrief, so it must be so hard for the students to concentrate on what is being said." (Field notes)
	A student tells me the classroom is "very noisy." (Field notes)
	The team also felt that the whiteboard "is nicer to write on, the flow is better and it is smoother." (Field notes)
	The student felt that "sketching on paper feels a little shitty because you're afraid you might destroy the paper" whereas, on the whiteboard, "it is nicer to write on." (Field notes)
	"There's a certain tactile element with the flip chart." (F4)
	A student shared "I feel more fulfilled with the whiteboard [and] somehow it is more aesthetically appealing and more organized." (Field notes)
	A student felt that the whiteboard is more "professional and high end when writing" while the butcher's paper is "a waste and is not cheap." (Field notes)

> sharing their ideas on environmental opportunities and threats. The scribe stands upright as he writes, slowly arching his back as his writing progresses down the paper. When he nears the bottom third of the page, he detaches the paper and re-attaches it higher on the wall so that he can resume writing in a more comfortable position. Over at the right-sided sheet of paper, a student begins writing an industry analysis and asks two other students for input. Trying to read what is being written, they stand on tiptoe and shift left and right before contributing additional content on industry forces, which the scribe writes on the paper. Taking a step to the side to allow an unimpeded view of the paper, the scribe asks, "Is everyone happy?" The two students review the written summary of the industry analysis and nod their heads. (Field notes)

As the vignette shows, team members who acted as scribes could choose where to position the paper on the wall according to their own physical needs and comfort. Our observations and photographs show individual students "shifting the paper down to eye level" (Field notes) and "moving it around" (S5). In addition, teams could adjust the location of the paper according to how they wanted to position their bodies as a collective. Team members clustered vertically "up and down around the paper sheets" (Field notes) and walked around to attach new and completed sheets to different spots on the walls. In one example, a team explained that they had purposefully positioned the paper to minimize encroaching on each other's personal space: "We put the general environment and industry analysis far apart so we won't squeeze" (Field notes). In another example, a facilitator described how students working with paper "get tired so they all just sit and have a little powwow in front of the paper, and they can bring that [paper] down" to floor level with them (F2). The data reveal that the mobility of the flip chart "gives students control" over their embodied experience of learning (Field notes). Some students belonging to teams comprising "a lot of short people" said their team "actually learnt to love [the paper] because … we are able to move it down" (S29).

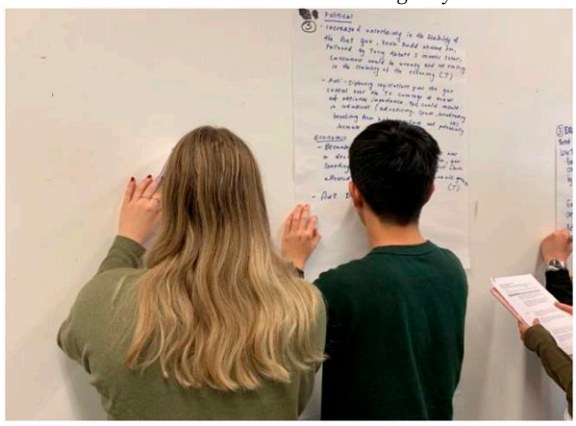
Summary. The analysis indicates that static and mobile locations influence team learning experiences through the way team members moved, physically coordinated, and oriented their bodies. When teams performed tasks using a material object that had a static location, they had to *work at* the object and felt less agency over their embodied learning experience in team processes. When students undertook tasks using a material object that had a mobile

TABLE 3
Representative Photographic Data on Material Objects and Team Learning

Location and embodied learning

Static location and less agency

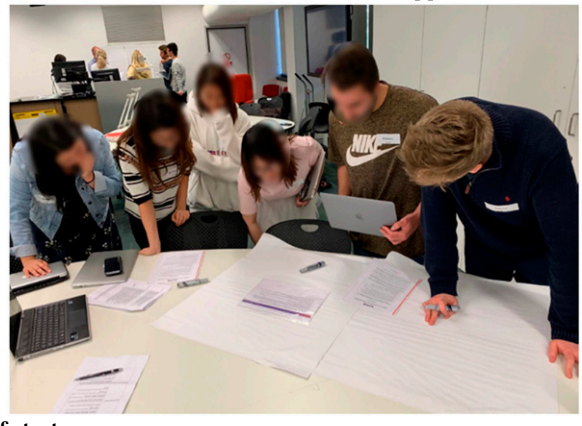
Mobile location and more agency



Record-keeping and use of tools

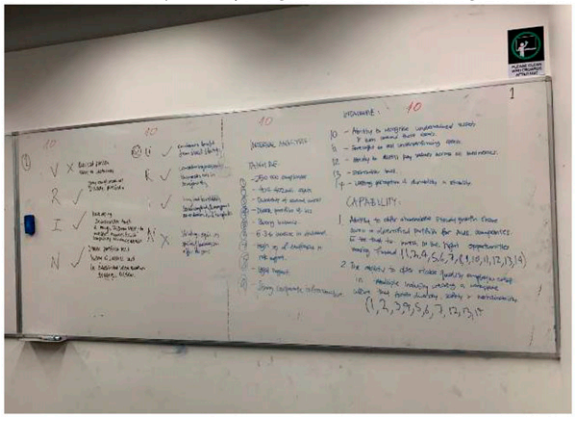
Temporary record, expansionist approach

Permanent record, reductionist approach

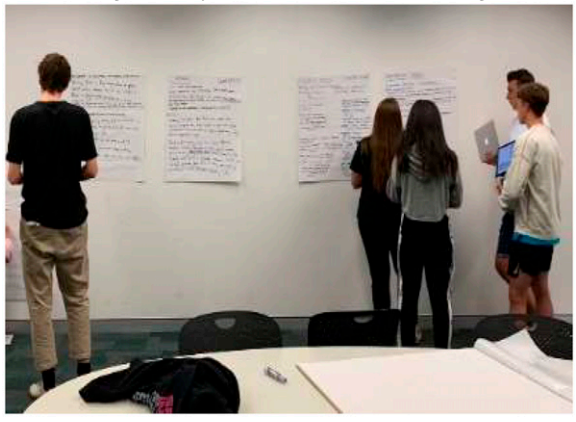


Form and understanding of strategy

Whole form, synergistic understanding



Segmented form, discrete understanding



location, they could *work with* the object and felt more agency over their embodied experience in team processes.

Object Record-Keeping and Team Learning Processes

The second object property that impacted team learning processes was *record-keeping*. Whiteboards provide teams with the ability to erase text, while text written on paper cannot be erased. Our data indicate that these temporary and permanent record-keeping properties influenced teams' approach to problem-solving.

Temporary record-keeping and expansionist approach. The vignette below illustrates how the temporary record-keeping property of the whiteboard enabled students to adopt an expansionist approach when solving problems using strategic frameworks:

> A group of students is undertaking a Porter's five forces analysis of an Australian television company. "Let's write down all of our ideas first," a student suggests. The scribe writes "media industry" at the top of the whiteboard. Team members brainstorm forces in random order. "Netflix and other streaming services are threats or substitutes," offers one student. The scribe scribbles each idea beside the appropriate force. When a student suggests that the "threat of new entrants" is the key force impacting overall industry attractiveness, the scribe says, "Can you write that idea at the side?" The student writes a sidenote on the whiteboard. The scribe continues writing ideas as everyone brainstorms. Team members then review the ideas. A student asks, "Are Netflix and streaming services substitutes for the media industry or rivals in it?" After discussion, the group revises their industry definition to "Australian commercial free-to-air television." The group continues reviewing the entire whiteboard, correcting spelling mistakes, deleting or rephrasing inappropriate ideas, and adding "YouTube" as another example of substitutes. They erase the sidenote and include it in the conclusion about industry attractiveness. (Field notes)

As shown in the vignette, teams felt comfortable recording their emergent strategic analyses on the whiteboard. Teams typically began writing their applications of strategy tools while discussion was still underway because they could "debate, write something stupid, and just rub it off" (S62) and "change your mind [and] rephrase" (S7). Their analyses expanded through discussion at the whiteboard, which served as a holding space for the accumulation of creative ideas and was captured in our real-time field notes and photographs. Students described how temporary record-keeping encouraged this expansionist approach to problem-solving: "We are just getting everything up and fixing it as we go because, when you brainstorm, we are adding more ideas every second" (S28). The whiteboard supported "changing ideas as we are going … because it just takes a second—you can add or write someone else's [ideas]" (S24). In a similar vein, facilitators noticed that, when teams worked at a whiteboard, the outcome of strategy-related problems "doesn't seem as set to them" (F9) so teams tended to adopt an approach of "running through ideas" (F8) that could later be "refined and challenged" (F1). By giving students the "freedom and luxury to write more creatively" (F3) and to generate "more ideas … for better discussion" (Field notes), the temporary record-keeping property of the whiteboard encouraged an expansionist approach to problem-solving.

Permanent record-keeping and reductionist approach. The permanent record-keeping property of the paper has a different impact on a team's approach to problem-solving. As shown in the vignette below, in which a different team of students is analyzing the same case company, the permanence of paper supports a reductionist approach:

> Standing beside a blank paper sheet, a team begins their Porter's five forces analysis for the Australian television company. Team members debate their industry definition. A student says, "We could define it as the 'television industry' but I'm not sure." The scribe picks up the marker to begin writing. "No, don't write yet," she warns and resumes talking through her ideas. After further discussion, the scribe writes "television" as the industry name. The team progresses to systematically talking through and recording each force. "Radio might be a possible substitute," a student proposes before shaking their head: "Forget it. I don't know how to justify radio in terms of what we've already written." Another student suggests Internet streaming is a potential substitute that fits their industry definition. Team members agree and deliberate over additional details such as YouTube and illegal streaming. They complete their analysis on the paper. For each force, they have written two main points, which are narrowly conceptualized and supported with descriptions and facts. During the debrief, the instructor says, "Good work. Although you adopted a very general industry definition, your analysis is tightly focused and consistent with that definition." (Field notes)

The vignette highlights how teams delayed writing on paper until after they had discussed the

application of strategy framework to the case company: "You have to discuss first to make sure what you wanted to put on [paper] is what the team agreed upon" (S1). The real-time observational data indicate teams assigned to paper tended to begin writing later than those assigned to whiteboards. Once teams started writing, their application of strategy tools to analyze strategic problems became more narrowly streamlined because "thoughts have to be final" (S19) and "more concise" (S18). The flow of ideas was "restricted, as in we can't brainstorm as much … once it is on the paper, we can't really change it or modify it" (S28). Our photographs of paper sheets depict a display space for ideas that have been refined and reduced through discussion, rather than a holding space for ever-expanding creative ideas. Since teams "can't backtrack" (S60) or "build on your answers at all because you can't just restart your sentence" (S25), strategic analysis tended to cohere around a single approach. Facilitators described how teams given paper "were more fixated on that particular idea … and developing that" (F9) and "can't experiment with ideas" through further discussion (F1). As students explained, "if you make a mistake on the flip chart, you just have to go with it and use it" (S59) and "just leave it and continue" (S48). Articulating how permanent record-keeping induces a reductionist approach to problem-solving, a student said, "Because it is permanent [once you start writing on paper], it definitely hinders your creativity and innovative thinking process" (S24).

Summary. The analysis indicates that temporary and permanent record-keeping influence team learning processes through the way they solved problems by applying strategy-related tools and frameworks to analyze the case company and its courses of actions. When a material object allowed temporary record-keeping, students adopted an expansionist approach to problem-solving. When a material object allowed permanent record-keeping, students adopted a reductionist approach to problem-solving.

Object Form and Team Learning Processes

The third property that impacted team learning processes was *object form*. A whiteboard exists as a whole form, while flip chart paper exists in segmented form, with teams provided multiple sheets of paper. Articulating this difference, a facilitator described how "students see two different distinct pieces of flip chart paper, whereas, on the whiteboard, they are on the same medium" (F1). Our data show that whole and segmented forms primarily influenced teams emerging conceptual understanding.

Whole form and synergistic understanding. The vignette below illustrates how the whole form of the whiteboard enabled a synergistic understanding of strategy frameworks:

> A team is conducting an internal organization analysis for a case company. They divide the whiteboard into left-side, center, and right-side columns and write the headings "resources," "capabilities," and "VRIN test" respectively. They split into subgroups. Group A discusses the company's tangible and intangible resources, listing ideas in the left column, including "management knowledge," as an intangible resource. Group B discusses capabilities and writes "skills and knowledge to maintain strong relationship with consumers, suppliers, and shareholders" in the center column. Reading the resources listed in the left column, Group B asks, "Could you add numbers beside your resources? It will be easier for us to bundle them together to guide our capabilities analysis." Group A numbers each resource and, after discussion, Group B writes the relevant numbers underneath their capability. When Group A completes their resources list, they notice there are several resources related to diversification: "We have a second capability from here." Group A suggests that Group B might consider "efficient acquisition" as a capability. Group B writes this on the whiteboard and, after discussion, adds the text "of new investment opportunities to enhance their profit and maintain as a strong competitor." When the two groups are satisfied that the capabilities build upon the resources in the left column, they work together at the right column of the whiteboard to conduct the VRIN test for the first capability, bringing forward pertinent ideas from their resource and capability analyses. (Field notes)

As shown in the vignette, working on the single surface area of a whiteboard supported team members to work collaboratively and integrate their insights, despite dividing up the task of conducting an internal analysis using the VRIN framework. This pattern was evident across the real-time observational data, which noted that "there is more integration and more people swap around between groups of three at the whiteboard" (Field notes). The photographs of whiteboards captured teams writing numerical and alphabetical codes and drawing arrows to signify linkages within and across strategy tools. Team members were able to see, notice, and connect different points of strategic analysis. As a student explained, "You can see things better in terms of the analysis because you can look at other stuff that's been written up and see what's

happening in the company as a whole" (Field notes). Facilitators noticed that, because team members were working together "within the same border, there are at least opportunities to make relationships across analysis" (F1).

The whole form of the whiteboard allows "more free flowing of information" (S58) among elements of strategic analysis. As students pointed out, "you can do arrows across" (S40) to demonstrate how insights gained from applying a strategy tool build upon and align with each other as a guide to future strategy. The whole form of the whiteboard helps team members "learn from other people's perspectives" (S19) and reflect on synergistic connections by "creating dynamics within [strategy tools and] information" (F1). A more synergistic understanding of strategy tools emerges because "everything on the whiteboard needs to connect together, perform some kind of synergy" (F6).

Segmented form and discrete understanding. In contrast to the whole form of the whiteboard, the segmented form of paper influenced a more discrete understanding of strategy frameworks, as illustrated in the vignette below:

> A team spreads three sheets of paper across the wall to conduct the internal analysis of the case company. They split into two subgroups. Group A works on analyzing resources on one sheet of paper, while Group B focuses on identifying capabilities on another sheet of paper. With minimal eye contact and communication between the groups, Group B discusses and writes the following resources on their paper: "diverse portfolio + shareholder base + shareholder loyalty." They write the capability name as "market leading ability to maximize returns to shareholders" and then proceed to conduct the VRIN test on this capability. Meanwhile, Group A is still identifying and recording resources, including "strong brand loyalty." Group A does not list "diverse portfolio" or "shareholder base" as resources even though these have been bundled into a capability by Group B. The students in each group stay fixated on their own task and look only at their own designated sheet of paper. During the classroom debrief, the course coordinator asks the team why their capabilities do not match with their identified resources. The team's spokesperson replies, "Sorry, I only worked on the resources. I did not do the capabilities." (Field notes)

The vignette shows that, when teams worked with multiple sheets of paper, teams undertook a more rigid division of labor in which they separated into contained subgroups with minimal communication and collaboration between them. As students pointed out, "it feels more divided" because "you can divide up tasks more at the paper and allocate people to work on tasks at separate sheets" (Field notes). Whereas the whole form of the whiteboard promoted interdependence, having access to their own sheet of paper allowed subgroups to conduct analyses of resources, capabilities, and VRIN as "separate and independent tasks" (Field notes). This made it more difficult for team members to see and make meaningful connections within and across their strategic analyses. The photograph data contained few arrows and other symbols that might connect a team's strategic insights across paper sheets. Struggling to "correlate everything across the different analyses" (Field notes), teams tended to display a discrete understanding of strategy tools.

Facilitators noticed how the segmented form of the paper held teams back in making meaningful connections across strategy frameworks. A facilitator pointed out that team members "were more focused on that one flip chart [in front of them now] … rather than looking back and integrating that [other] information into what they're working on" (F9). Reinforcing this point, another facilitator said that, when analyses are conducted on two separate sheets of paper, team members "see this as quite distinct things on two different distinct pieces of flip charts" and it becomes "more difficult to encourage links" across analyses (F1). When frameworks become "spread across two or three different papers," teams "find it hard to coordinate activities" (S52), producing a more discrete conceptual understanding.

Summary. The analysis indicates that whole and segmented forms influenced team learning processes through conceptual understanding of strategy frameworks. When a material object had a whole form, teams exhibited a synergistic understanding of strategy concepts and frameworks. When a material object had a segmented form, teams' conceptual understanding of concepts was more discrete.

Object Sensation and Team Learning Processes

The fourth object property that impacted team learning processes is *sensation*. Whiteboards and flip charts created different visual, aural, and tactile sensations through the way they look, sound, and feel. The data reveal that, for some students, object sensation can influence experiences of team learning:

> The strategy classroom can be an assault to the senses. The whiteboards sit big and bold on the walls surrounding the perimeters of the room. They feel cold and smooth on the skin when touched. Paper feels rougher to touch, taking on the tactile quality of the

> wall on which the sheets are pasted. Pens make continuous tapping sounds like machine guns when writing on whiteboards; they produce squeaky sounds on paper. The classroom bustles with the voices and energy of both students and facilitators, punctuated every so often with the loud noise of individual paper sheets being ripped from the flip chart. (Field notes)

As the above vignette illustrates, whiteboards and paper create a variety of sensory stimuli, which individual students noticed to greater and lesser degrees. The most commonly perceived sensory stimuli was aural, with many students finding the classroom experience noisy. Sounds were generated by (a) pens tapping and squeaking as they came into contact with the whiteboard and paper when writing, respectively; (b) group discussions around the whiteboard and paper and as facilitators probed students on their analyses; and (c) removal of paper sheets from the flip charts. The sound of writing instruments were least noticeable to students, while a lot of students perceived concurrent discussion groups to be "noisy" and "very loud" (Field notes). A few students felt the ripping of paper sheets was "extremely distracting" (F5) and "annoying" (S2). As a facilitator highlighted, "the whole ripping adds on to the hectic nature of the environment" (F3).

Some students also noticed tactile sensations as they interacted with the material objects during team learning processes. Whiteboards have a "smoother surface" of cool temperature, which some students sensed and enjoyed under their hand when writing (Field notes). Other students noticed the "rough" surface of the paper and the "friction" created when writing (Field notes). Generally, students found that the whiteboard was "easier to write on" (S13, S17). A student described her preference of the whiteboard specifically "in terms of feel, because it is smoother and nicer and it feels sleek and quick" (S29). On the other hand, comments suggested a negative affective experience of learning arising from the lower "tactile quality" (F4) of the paper. A few students remarked that "it is frustrating when you start to write on paper" (Field notes) and "pens dry out on paper" (Field notes). Facilitators noticed that many students perceived there were different tactile sensations in the "ease of writing on the whiteboard as opposed to the flip chart" (F4).

Finally, the visual look of an object aroused felt sensations for some individuals. Since the purpose of both the whiteboard and the paper was for teams "to write and to present ideas visually" (F4) and "displaying [them] loud and proud around the room" (F5), some students made judgments about the aesthetic appeal of the objects which affected how they felt during team learning processes. A few students felt that using the whiteboard was "more aesthetically pleasing [and] creates more fulfilment" (Field notes) and they "feel powerful like a teacher—more professional" when working at the whiteboard (Field notes). In contrast, paper was judged by some students as having poor visual appeal and inferior status. Expressing these negative feelings, a student said bluntly, "Whoever gets the flip chart is, like, the dud group of the week" (S50). Other students asserted that paper is "just shit [and] not environmental" (Field notes), while some perceived that paper "looks messy" (S27).

Overall, the analysis indicates that sensory stimuli associated with the whiteboards and flip chart paper did not have a noticeable impact on team learning behaviors in the same way that object location implicated physical movements of bodies. However, for some individual students, felt sensations as they used the material object could arouse positive or negative emotions that influenced their experience of team learning processes.

DISCUSSION

In this paper, we joined calls for management education researchers to develop deeper understanding of how material objects affect learning (Taylor & Statler, 2014). Given the broader organizational literature on affordances and sociomateriality suggests student participation in team learning processes is being constrained and enabled by material objects in ways that remain hidden to management educators, we asked *how do material objects shape team learning processes?* We investigated this research question through a qualitative inductive study of student teams working with two types of mundane material objects—whiteboards and flip charts—in an undergraduate strategy classroom. Our findings identified four properties of mundane material objects that are more and less salient to how students participate in team activities in class: object location, object record-keeping, object form, and object sensation. We present a summary of the theoretical propositions that emerged from our findings in Table 4.

Theoretical Contributions

Our study contributes to the literature on student team learning, where the question of how educators can support experiential learning processes (Kolb, 1984) remains of interest even after decades of

TABLE 4
Overview of Object Properties and Theoretical Propositions

Properties	Dimensions	Theoretical Propositions
Location	Static	When the location of a material object is static, team members feel they have less agency over their embodied learning experience.
	Mobile	When the location of a material object is mobile, team members feel they have more agency over their embodied learning experience.
Record-keeping	Temporary	When the record-keeping of a material object is temporary, teams adopt an expansionist approach to problem-solving.
	Permanent	When the record-keeping of a material object is permanent, teams adopt a reductionist approach to problem-solving.
Form	Whole	When the form of a material object is whole, team processes foster a synergistic conceptual understanding.
	Segmented	When the form of a material object is segmented, team processes foster a discrete conceptual understanding.
Sensation	Auditory Tactile Visual	Sensations aroused by using mundane material objects tend not to be noticed by students in ways that affect participation in team learning processes. Sensations that arouse strongly valenced emotions (positive or negative) may impact student satisfaction.

research (Morgan & Stewart, 2019). In contrast to prior studies that focus on team composition and selection (Chapman et al., 2006; Wilcoxson, 2006), team tasks (Ashraf, 2004; Bacon, 2005; Hansen, 2006), team assessment and peer evaluation (Brutus et al., 2013; Ferrante et al., 2006; Johnston & Miles, 2004; Ohland et al., 2012), and team preparation (Chen et al., 2004; Snyder, 2009) in their accounts of student team learning, our study brings attention to how material objects matter in team learning processes. Our findings extend the burgeoning literature on student team learning by opening up new insight into how student participation in teams is both constrained and enabled by the distinctive properties of material objects that team members interact with. In doing so, we show the value of the concept of affordances, as possibilities for actions and uses arising from the materiality of an object (Zammuto et al., 2007), for clarifying and deepening understanding student learning processes. Thus, our study advances the management education literature by bridging closer connections with the literature on sociomateriality (Boxenbaum et al., 2018; Orlikowski, 2007).

Offering a counter to the attention focused on playful material objects in the management education literature (e.g. Coff & Hatfield, 2003; Donovan & Fluegge-Woolf, 2015; Taylor & Ladkin, 2009; Verzat et al., 2009), we shine the spotlight on two material objects—whiteboards and flip charts—that are often overlooked because of their ubiquitous nature (Jarzabkowski et al., 2013). By explicating the qualitatively different ways in which these two seemingly similar objects shape a team's problem-solving behaviors (Goltz et al., 2008) and conceptual understanding (Ramsden, 2003; Whetten, 2007), our study offers a deeper and more nuanced account of the relationship between material objects and the processes of student team learning. Rather than producing a single consistent impact on team problem-solving behaviors (Goltz et al., 2008), whiteboards and flip charts have very different record-keeping affordances (temporary, permanent) that shape whether student teams engage with problems by expanding or reducing their thinking respectively. So, too, whiteboards and flip charts have different forms (whole, segmented) that shape team member possibilities for thinking and action to build synergies across their understanding of distinct course concepts—or not. By revealing how the form and record-keeping properties of mundane material objects influence what teams do to reflect, conceptualize, and solve problems during team learning experiences, we provide researchers and educators with a new piece of the puzzle of how experiential learning processes unfold collectively rather than individually within student teams (Bacon & Stewart, 2019; Kolb & Kolb, 2005; Rafferty, 2013; Tomkins & Ulus, 2015).

In addition, our findings add empirical confirmation to an implicit assumption in management education practice that mundane material objects do not typically create a sensory stimulus for learning to the same degree that playful objects do (Taylor & Statler, 2014). Educators have posited that, when teams interact with arts-based objects and toys during team learning tasks, students experience enhanced

sensory awareness and positive emotions like fun and curiosity (Kempster et al., 2015; McNeely, 1994; Sheehan, 2006). In contrast, most students in our study were unaware of sensory cues when working at either the whiteboard or the flip chart. This general pattern was unsurprising, given that using mundane material objects in expected ways during student team tasks is unlikely to arouse the obvious sensory processes of using objects imaginatively for "hands-on" learning of course concepts. There were, however, a small number of students in our study who experienced strong sensory cues. Resonating with Vince's (2011) study of chair positions in management classrooms, some students felt more powerful standing at the whiteboard (positive sensations), while others noticed the rough feel of the paper and felt inferior when using it (negative sensations). Since this finding implies that mundane material objects do not produce a single stimulus of low intensity across all students, future research is needed to untangle the relationships between different types of material objects, sensations and emotions, and team learning processes. Of particular interest are the factors that influence whether a learner's interaction with a mundane material object arouses sensations that undermine or enhance their learning experience and student satisfaction.

Finally, our study contributes to ongoing scholarly debates about how to teach strategy courses to build student's competencies and skills in applying strategy theories and tools as future business practitioners (Grant, 2008; Grant & Baden-Fuller, 2018; Priem, 2018). This literature has featured critique on overly theoretical ways of teaching strategy which ignore practical skills (Greiner et al., 2003), hamper creativity and complex thinking (Ghoshal, 2005), and encourage rigid and mindless application of strategy tools (Clegg, Carter, & Kornberger, 2004). Our findings advance this critique by shifting attention from *what* should be taught in strategy courses to *how* strategy can be taught using material objects to facilitate greater integration of strategy theory and practice. In particular, our study highlights how educator choices about the use of mundane material objects in classrooms can enable student learning processes about the application of strategy tools to business cases. Building on the strategy-as-practice turn, which considers the human activity involved in accomplishing strategy through the tools, norms, and routines of strategizing (Jarzabkowski, 2008), our findings highlight the value of embracing a more sociological approach and a practice perspective in strategy teaching. Our findings shine light on how common material objects used in the *doing* of strategy by managers in organizations (whiteboards and flip charts) also constrain and enable student learning about the *doing* of strategy in classrooms.

Practical Implications

Our study has practical implications for management educators. As educators consider *what* and *how* they teach with teams to facilitate content-related learning and developing teamwork competencies, our findings suggest educators need to actively consider material objects within the "how" of teaching. Our findings encourage educators to look at the ubiquitous material objects in classrooms with fresh eyes as pedagogical tools that are available to be actively designed into team tasks to foster particular team learning behaviors. Just as educators can bring playful objects like toys and crafts into the classroom to foster more creative problem-solving (Coff & Hatfield, 2003; Donovan & Fluegge-Woolf, 2015; Roos & Victor, 1999, 2018; Verzat et al., 2009), so too educators can creatively design team learning tasks that draw on the properties of mundane classroom objects to afford possibilities for expansionist problem-solving behaviors and more synergistic thinking. While we specifically focused on whiteboards and flip charts in our study, educators might also consider how the location, form, record-keeping, and sensory cues of other material objects such as desks, visual monitors, and PowerPoints afford different possibilities for action that shape learning behaviors during team tasks.

Our findings suggest that educators might use material objects to resolve some of the challenges of team learning identified in the literature. Educator responses to behavioral and structural issues in student teams have tended to be directed at improving team culture and psychological safety through teamwork training and clear goals and roles (e.g., Cajiao & Burke, 2016; Erhardt, 2011; London & Sessa, 2006). Our findings suggest these approaches are likely to be more effective if educators also consider the material objects that teams are interacting with and the types of team behaviors they encourage. For example, whole-form objects and temporary record-keeping might help produce a psychologically safe environment for open discussion of thoughts and ideas (Cajiao & Burke, 2016). When teams work with material objects that afford permanent rather than temporary record-keeping, educators might try to counter the tendency for reductionist problem-solving by creating roles for a team leader to

consolidate decisions and a scribe capable of skillfully conveying shared ideas.

We suggest the concrete experience of student learning is likely to be shaped by the ways in which mundane material objects encourage and discourage dialogue and reflection (Kolb & Kolb, 2005). A practical implication of our study is that educators who understand the properties of different types of material objects can become more alert to opportunities through which to leverage those properties to encourage deeper reflection in experiential learning cycles. For example, the permanent record-keeping property of flip charts enabled the instructor and facilitators to better engage in teachable moments as a prompt for reflection. This was because the flip charts made visible how team problem-solving had evolved through applying the frameworks of strategic analysis, while the work of teams on whiteboards had often been erased to facilitate other work. We encourage educators to consider how they might take advantage of the properties of different material objects to provide formative feedback to prompt reflection, thinking, and action in experiential learning cycles.

Another practical implication that emerged from our study was how students can change the possibilities for action of material objects by combining them with digital objects during team learning processes. While it was beyond the scope of our study to investigate, we nevertheless noticed that individual team members used their own digital devices—such as mobile phones, laptops, and tablet devices—in combination with their assigned whiteboard or flip chart. As highlighted in some of the vignettes in our findings, students stored their own preparation notes for the management team meetings on their digital devices and referred to them during the team discussion to produce the shared output on the whiteboard or flip chart. That is, instructor-assigned physical classroom objects used by teams can be combined with student-selected digital objects used by individuals. Educators need to be aware that these combinations of physical and digital objects will afford new and unexpected possibilities for student actions, which may support or undermine the team learning processes the educator was intending to foster.

The combination of physical and digital objects in classrooms, and how they change affordances, has practical implications for management educators—and also opens up an interesting direction for future research in online learning (Arbaugh, 2014). The move to online teaching during COVID-19 has brought to the fore the imperative for educators to actively think about the properties of different types of material objects—physical and digital—that can be used to support face-to-face and online teaching. Educators are using physical whiteboards in web-based and video teaching online, and are experimenting with digital solutions that mimic the whiteboards and flip charts that materialize team learning in physical classrooms as we studied here. In our course, we experimented with moving the management team meetings online using shared editable online documents (Google Docs) as a digital substitute for the physical whiteboards and flip chart paper we used during management team meetings in our face-to-face classroom teaching. The editable online document blended the segmented form of flip chart paper with the temporary record-keeping property of a classroom whiteboard. We found that segmented form fostered discrete conceptual understanding and temporary record-keeping fostered expansionist problem-solving, to the point that teams working together online took far longer to complete team tasks. More and more potential problems and solutions were generated for the case company but without any synergies being created between them to help whittle down the preferred alternatives. We encourage educators to consider the differences in properties between physical and digital objects, and how they shift the possibilities for action during team tasks in online learning environments, and we recommend future research along this path (Arbaugh, 2014; Cheng & Chau, 2016).

Limitations and Future Research

Like all interpretive research, the aim of our research inquiry was to explore and explain phenomena, and the single qualitative study we chose for our empirical investigation imposes limitations on the generalizability of our findings. Our data collection was focused on two types of mundane material objects (whiteboards and flip chart paper), one type of course (strategy course), one type of student (final-year undergraduate), and a single university (located in Australia). Future research is therefore needed to explore the extent to which the properties of material objects that shaped team learning processes in this particular context are generalizable to (a) other types of mundane material objects, as well as playful objects and digital objects; (b) other strategy courses and other courses in management programs; (c) other undergraduate students and to postgraduate and MBA students; and (d) other

university contexts internationally. We encourage research using a variety methods, including rich case studies using longitudinal data collection of teams working with different types of material objects and quantitative designs, such as large-scale surveys, with which to verify and test the emergent theoretical propositions from our study.

While our study did not allow us to investigate the outcomes of team learning processes, our findings open directions for future research on performance of student teams. This research has tended to follow the broader organizational literature on work teams by focusing on antecedent conditions of team performance (Knapp, 2010), which for student teams include contextual factors of behavior and team structure. Behaviors that have adverse effects on performance in student teams include social loafing (Jassawalla et al., 2009), collaborative cheating (Briggs et al., 2013), and conflict (O'Neill et al., 2017). Structural factors leading to poor team performance are found in the team's makeup, such as homogenous group composition (Aggarwal & Williams Wooley, 2019) and poorly defined roles (Ainsworth, 2016). Our findings suggest that team member behaviors and team structure are partial explanations of poor performance because they ignore how material objects afford possibilities for different ways of behaving among the students who make up the team. Material objects with segmented form, for example, may afford division of labor among team members and reduced monitoring of fellow team members' contributions, which prior studies report are antecedent conditions for social loafing behaviors (Bacon, 2005; Jassawalla et al., 2009; Slavin, 1988). We conjecture that there is also potential for static material objects to create antecedent conditions for behavioral conflict by affording individuals less agency over their own bodies when working together, which research on embodied learning suggests might also reduce student's engagement and satisfaction (Cunliffe & Coupland, 2012; Gartner, 2013). Thus, our findings contribute insights that invite future research to help clarify and refine understanding of the role that material objects might play in student team performance and student satisfaction as an outcome of a learning process. We encourage more researchers to follow our path of exploring material objects in team learning processes.

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