



Team Performance Management

Clear as a Bell: The Influence of Analogies on the Development of Cross-understanding in Design Teams

Journal:	<i>Team Performance Management</i>
Manuscript ID	TPM-04-2018-0028.R1
Manuscript Type:	Research Paper
Keywords:	Analogy, Diverse teams, Design, Cross-understanding, Knowledge application, Communication

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Introduction

Organizations increasingly depend on teams of knowledge workers to **design** new products and services (Edmondson & Nembhard, 2009). These teams are often composed of individuals from diverse backgrounds, allowing members to draw from extended knowledge resources (e.g. Dahlin *et al.*, 2005). Because teams often fail to effectively apply this distributed knowledge pool to their tasks, researchers have called for identifying specific communication **modes** needed to optimally process diverse information (c.f. van Knippenberg *et al.*, 2004).

In this paper, we suggest that analogy is a communication mode that can facilitate team information processing through improving communication effectiveness (the intended message is successfully delivered and understood). Research in psychology describes analogy as a cognitive process to convey knowledge through linking unfamiliar information to what is already understood, improving comprehension of unknown concepts or ideas (e.g. Gentner, 1998). For example, the production analogy of “a Model T is like a dead cow” associated Ford Motor Company’s assembly process with a beef processing plant (Pollack, 2014), helping Ford to advance its production methods. We adapt the above conceptualisation and define analogy in teams as a communication mode that links unknown information to something known.

Although psychology research has identified analogy as a key construct for information processing on the individual level, team research has largely overlooked analogy as a communication mode (Paletz *et al.*, 2013) and has instead focused on communication frequency (number of communication occurrences per unit of time) as a predictor for team information processing (c.f. Liao *et al.*, 2012). Measuring just the frequency of communication interaction assumes that knowledge is relatively easy to transfer and integrate (Kotlarsky *et al.*, 2015); however, this might not always be the case, especially in diverse design teams where members

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4 represent a broad base of knowledge designed to increase their ability to perform complex tasks
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6 (Clark *et al.*, 2000). We posit that analogy is a stronger predictor for team information processing
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8 compared to communication frequency and, therefore we will examine both, communication
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10 frequency and analogy as independent variables. We theorize that whereas analogy will have a
11
12 direct relationship to knowledge application, and an indirect effect via cross-understanding,
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14 communication frequency will have only an indirect effect on knowledge application through
15
16 cross-understanding.
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20 Cross-understanding reflects the degree to which individual team members have a precise
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22 understanding of one another's mental models in respect to their team task (Huber & Lewis,
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24 2010). According to Huber and Lewis (2010) a high level of cross-understanding should lead to
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26 improved information processing. Yet, achieving a high level of cross-understanding in diverse
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28 teams can be difficult as the individual team members' task mental models are quite diverse
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30 because they developed partly through their previously acquired knowledge (Cronin & Weingart,
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32 2007). Although it has received some attention since its introduction (e.g., Ren & Argote, 2011),
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34 empirical support has been limited to Meslec and Graff (2015), which showed that cross-
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36 understanding mediates the relationships between openness to cognitive diversity, reflective
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38 communication cognition and team performance.
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43 As a specific outcome of information processing, we refer to knowledge application as
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45 "existing knowledge is brought to bear on the problem at hand" (Alavi & Tiwana, 2002, p.
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47 1030), which is essential for successful design teams (Song *et al.*, 2005). Applying knowledge in
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49 a diverse team may be complex because the members represent a broad base of knowledge,
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51 which is desirable because it allows these knowledge-diverse teams to make better decisions and
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53 be more creative in complex and creative cognitive tasks than relatively homogeneous teams
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(Clark *et al.*, 2000). Analogy and cross-understanding should help individual team members to overcome this complexity.

In this study, we analyse individuals and their dyadic relationships with other members within each team, which is appropriate to the manner in which knowledge transfer occurs through our constructs of analogy and cross-understanding, rather than relying on aggregate group means which may mask more nuanced influence (Espinosa & Clark, 2014). Teams are composed of individuals and their relationships; thus, retaining individual and dyadic information provides us with a better understanding of knowledge application because information, assistance, and guidance, which are important for knowledge application, flow through these relationships (Cross & Cummings, 2004; Sparrowe *et al.*, 2001).

We contribute to the existing understanding of teams as information processors (Hinsz *et al.*, 1998) in two major ways. First, we gain novel insight by examining how analogies affect information processing in diverse teams. While information processing research has generally identified communication as an important indicator for team effectiveness, we identify and test a particular communication **mode**, analogy, that can enhance information processing in teams. As pointed out by Paletz *et al.* (2013), very little research has explored the effect of analogies on team process and performance outcomes. Yet, many researchers have studied the effect of analogies within the team context for other purposes (e.g. Chan & Schunn, 2015), indicating the importance of analogies within teams. By studying analogies alongside communication frequency, we extend previous research by distinguishing between communication frequency and a particular communication **mode**.

Second, this paper supports development of the cross-understanding construct proposed by Huber and Lewis (2010) as a team cognition factor affecting team process and performance

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4 outcomes, which so far has not been the subject of much empirical investigation (Meslec &
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6 Graff, 2015). This study will contribute to the developmental utility of this construct by
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8 identifying two additional antecedents, communication frequency and analogy, as well as one
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10 outcome related to cross-understanding, knowledge application.

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13 Next, we will identify potential connections between the variables (see Figure 1). We theorize
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15 that the relationships of analogy and communication frequency to knowledge application will be
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17 mediated by cross-understanding. We then test these relationships, describing our methodology
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19 and results. Finally, we discuss the limitations and implications of this study.
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24 **Analogies, Cross-understanding, and Knowledge Application in Teams**

25 *Analogy and cross-understanding*

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29 When used in communication, analogies link specific knowledge to a general domain, revealing
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31 task and personal mental models, and as such are well-suited to support the development of
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33 cross-understanding in a diverse team. For example, a designer could link design processes (an
34
35 unfamiliar target) with general product development knowledge (a familiar source) when
36
37 discussing prototyping with an engineer and manager. In this way, the manager and engineer
38
39 learn about the target (the task at hand, design processes) through the structural similarities with
40
41 the source that they already know. The specific analogies used may also indicate personal
42
43 background and interests, such as by choosing examples from particular industries or interests
44
45 like sports or pop culture, similarly to other modes of communicating information (Wang & Noe,
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47 2010).
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52 **On the individual level, analogies** have been shown to be effective for learning and
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54 understanding new consumer products (Gregan-Paxton *et al.*, 2002) and innovation (Sifonis *et*
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4 *al.*, 2006). In newly-formed diverse teams, wherein members are not yet familiar with each
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6 other, analogies linked to general concepts may leverage each member's unique knowledge to
7
8 clarify project goals and improve understanding of required features (Kalogerakis et al., 2010).
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10 In addition, analogies can provide visual imagery between a designer and customer to increase
11
12 usefulness of the product (Dahl *et al.*, 1999). Kalogerakis and colleagues (2010) proposed that
13
14 similar effects could occur in concept development teams. This improved communication should
15
16 lead to better cross-understanding; thus:
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20 *H1.* The use of analogies is positively associated with cross-understanding within dyadic
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22 relationships in a knowledge-diverse team.
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26 *Analogy and knowledge application*

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28 Analogies enhance knowledge application by increasing communication effectiveness through
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30 information content and persuasion. Knowledge application may fail because the recipients do
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32 not consider the information received to be relevant and applicable to their context (Argote &
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34 Epple, 1990). Through linking previously disparate knowledge domains, analogies can better
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36 realize that the intended message is successfully delivered and accepted by the recipient (Krauss
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38 & Fussell, 1996). Further, analogies decontextualize domain-specific knowledge by linking
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40 underlying structural similarities from a source to a target rather than by highlighting discipline-
41
42 specific knowledge. This makes the information more acceptable to the recipient. Once abstract
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44 knowledge is shared, the team is better able to apply it to an existing context or recontextualize it
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46 (Loewenstein *et al.*, 1999).
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52 In addition, we suggest that analogies can support knowledge application by virtue of their
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54 persuasive nature. Sharing knowledge alone is insufficient to assure selection of best alternatives
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(De Dreu & West, 2001); the recipient must also be convinced that the proffered alternative is the best way to solve the problem (West, 2002). As such, it is not only difficult to describe and share knowledge, but also to influence and motivate the recipient to apply the knowledge (Hinds & Pfeffer, 2003). Analogies might be used to persuade (Gentner, 1998), particularly in politics (Whaley, 1998), and may also apply to product launches to facilitate acceptance by consumers and link emotional analogies to products to enhance persuasiveness (Goode *et al.*, 2010). Application of knowledge within a team may require finding the right argumentation, which analogies provide through their persuasive nature (Gentner, 1998). Hence:

H2. The use of analogies is positively associated with knowledge application within dyadic relationships in a knowledge-diverse team.

Communication frequency as an antecedent to cross-understanding

Communication frequency among team members is important for the development of cross-understanding because it helps members to recognize one another's expertise, and to develop an understanding of who-knows-what (Reagans & McEvily, 2003).

Additionally, frequent communication in the beginning of a project helps to convey information about who possesses what knowledge, and how this knowledge may be helpful in achieving the team's objective (Lewis, 2004). During early interaction members can explain the knowledge, skills, and attitudes they are bringing to the team (Hollingshead, 1998). Such communication can help to deepen understanding or expose lack of insight into each other's knowledge, beliefs, preferences, and sensitivities by questioning, refining, and elaborating (Huber & Lewis, 2010).

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Frequent communication should also allow for more reliable cross-understanding by developing a shared conceptualization of the task and a common language that can provide a better fit for the knowledge (Cannon-Bowers *et al.*, 1993). Further, frequent communication can improve the efficiency of communication through relationship-specific heuristics (Uzzi, 1997) and hence increase understanding of each other's task mental models. Thus:

H3. Communication frequency is positively associated with cross-understanding within dyadic relationships in a knowledge-diverse team.

The relationship between cross-understanding and knowledge application

Cross-understanding affects knowledge application through tailored communication and understanding (Huber & Lewis, 2010). Dyadic relationships that have a high level of cross-understanding will be able to communicate better since the discussion is based on common ground (Clark, 1985). Such common ground allows the person conveying knowledge to use words and concepts that are easily understood by the recipient. This allows the recipient to not only better understand the knowledge source, but also to accept the argument (Krauss & Fussell, 1996) and thus increase applicability of the exchanged knowledge.

Cross-understanding also enables team members to pool their individual knowledge (Huber & Lewis, 2010), search for required knowledge, and apply it to the task (Alavi & Tiwana, 2002). Further discerning the team knowledge allows individuals to anticipate task requirements and apply knowledge dynamically (Rico *et al.*, 2008).

Transactive memory systems develop through this exchange of knowledge (Liao *et al.*, 2012), providing opportunity for knowledge application through knowledge integration (Lewis, 2004).

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4 Cross-understanding involves discerning what knowledge is needed and adjusting dynamically to
5
6 that knowledge, likewise enhancing knowledge application (cf. Faraj & Sproull, 2000). Hence:
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8 *H4.* Cross-understanding is positively associated with knowledge application within dyadic
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10 relationships in a knowledge-diverse team.
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15 As noted in the arguments for Hypothesis 2, analogies contribute directly to knowledge
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17 application by leveraging heterogeneous knowledge. We also argue, in Hypothesis 1, that
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19 analogies are associated with the development of cross-understanding. Together with Hypothesis
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21 4 that associates cross-understanding with knowledge application, these arguments lead us to
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23 propose:
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26 *H5.* Cross-understanding partially mediates the relationship between analogies and
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28 knowledge application within dyadic relationships in a knowledge-diverse team.
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33 Similarly, we note in the arguments for Hypothesis 3 that communication frequency is associated
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35 with the development of cross-understanding. Therefore, we theorize that cross-understanding
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37 fully mediates the relationship between communication frequency and knowledge application.
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39 Previous research has demonstrated that communication alone is not enough to influence and
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41 persuade others to utilize a particular type of knowledge (De Dreu & West, 2001). Consequently,
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43 we propose:
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46 *H6.* Cross-understanding mediates the relationship between communication frequency
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48 and knowledge application within dyadic relationships in a knowledge-diverse team.
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Method

Data for this study were collected from team members conducting a live, 3-week concept development project as part of a graduate program at a large European University. We gathered data at three points, first collecting background information (demographics and familiarity) before the start of the project (Time 0). After the first week of work, we collected the independent variables of analogies and communication frequency (Time 1), then collected again immediately after the project the mediator (cross-understanding) and dependent variable (knowledge application) (Time 2).

Out of the 49 members invited, 38 completed all three questionnaires (78% response rate). Twelve of the respondents had a bachelor's degree in design, 12 in business, 13 in science and technology, and 1 other (see Table 1). The respondents averaged 26.58 years of age, originated from 10 different nations, averaged 35.87 months of professional experience, and were 55% female.

Insert Table 1 here

The students worked with a client whose business processes bring together actors across creative industries. The client required an integrated deliverable, based on 14 complementary subtheme tasks for 14 teams (3 to 4 members each). The project goal was to address the challenges and future outlook of "brick and mortar" businesses, developing concepts for the local actors in 2020 that required a mix of management, design, and engineering expertise. Examples of the subthemes were "improving customer experience in stores" and "virtual business

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4 **development**". The client worked with the teams to determine the scope and deliverables of the
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6 project, interacting **with the team** as needed.
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8 Students formed subteams with the requirement that each would have one engineering, one
9 business, and one design student across at least two nationalities. Upon formation, the subteams
10 were notified of the overall assignment and the subthemes, then **were allowed to choose** their
11 own subtheme. No changes in subteam membership or subtheme were permitted.
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17 The project ran parallel with supporting sessions related to project management, design
18 research, problem reframing, creativity, prototyping, business modelling, and communication.
19 During the three-week course the students had no other classes, spending full working days
20 together. All subteams were required to produce a progress report halfway through the project
21 and to submit an integrated client report and presentation for the 14 subteams together. This
22 required the students not only to work within their subteam to develop a subtheme solution, but
23 also discuss and coordinate with the other subteams. Therefore, as the project progressed, the
24 subteams formed communication links with one another to ensure that the individual components
25 of the teams fit each other's solution and were integrated into the overall deliverable.
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40 *Measurements*

41 All items, if not otherwise stated, were measured using a seven-point Likert scale, from 1
42 (strongly disagree) to 7 (strongly agree). The level of analysis was the individual, studied
43 through each individual's communication relationships within the diverse team, reflecting the
44 dyadic manner in which knowledge transfers (Espinosa & Clark, 2014). We applied a one-with-
45 many dyad design, wherein the actors report their relationships with partners (Kenny *et al.*,
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54 2006).
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4 We collected the data from within and outside of each subteam through a combination of
5 sociometric and egocentric techniques (Wasserman & Faust, 1994), first asking each respondent
6 to describe communication relationships with every other subteam member (sociometric).
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8 Because this technique can lead to inaccuracies for subteams operating within larger teams, we
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10 also used the egocentric approach (Reagans & McEvily, 2003) which asked respondents to list
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12 up to three people with whom they had been communicating across subteams. Together the
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14 approaches totalled 146 dyadic relationships, an average of 3.84 dyads per respondent. There
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16 were fewer than possible dyads (228; 6 x 38 participants) due to the voluntary number of cross-
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18 subteam dyads selected, and differences in reporting from Time 1 to Time 2. Once respondents
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20 identified each dyadic partner, they reported their communication interactions.

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26 Analogy. Because development of analogy use measures has been limited, we adapted a scale
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28 (Hanke, 2006) measuring perceptions of how others (dyadically rated) use analogies in team task
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30 processes. The scale was anchored with a seven-point scale, ranging from 1 (never) to 7 (very
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32 frequent). To test if our adapted items influenced the prior factor structure, we performed a
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34 confirmatory factor analysis (CFA), evaluating the model by using several fit indices, including
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36 chi-square, ($\chi^2 (5) = 14.15, p < .015$), goodness-of-fit (GFI = .959), comparative fit index (CFI =
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38 .975), and root mean square error (RMSEA = .11) for all items of the scale. While there is no
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40 universal cut off value to determine adequate model fit in CFA (e.g., Fan & Sivo, 2007), the
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42 modification indices suggested a better model would eliminate item 2 (because its error term
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44 covaried with item 3 and 4). We used the resulting 4-item measure (listed in Appendix) in a CFA
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46 (Figure 2), which demonstrated a good fit ($\chi^2 (2) = 1.51, p < .47$) with all indices (GFI = .995,
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48 CFI = 1, RMSEA = 0) falling within the acceptable ranges (Hu & Bentler, 1999). Cronbach's
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50 alpha showed an acceptable value of .84 (Nunnally, 1978).
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4 **Communication frequency.** Communication frequency was measured with one item asking
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6 respondents to report how frequently they had talked with each other since the project started.
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8 This was measured using a seven-point Likert scale, from 1 (never) to 7 (very frequent).
9

10 **Cross-understanding.** Cross-understanding was measured with a nine-item scale proposed by
11
12 Huber and Lewis (2010). The items were carefully adjusted to fit the sample and its tasks;
13
14 sample items include “This member chooses concepts and words that I understand” and “This
15
16 member prompts me to surface and discuss what I know, believe, or prefer.” Question 3 had a
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18 very low correlation in all analyses, perhaps due to the systematic error often associated with
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20 reverse-scored items (Jackson *et al.*, 1993), and was therefore dropped. The Cronbach Alpha for
21
22 the scale is .78, acceptable for an explorative study (Nunnally, 1978).
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26 **Knowledge application.** For knowledge application, we used a three-item scale developed by
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28 Choi *et al.* (2010), adapting it to the dyadic level; e.g., “This person uses knowledge to solve new
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30 problems”, “This person applies knowledge learned from experience” and “This person applies
31
32 knowledge to solve new problems.” This scale had a Cronbach Alpha of .88.
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36 **Control variables.** We controlled for subteam membership, familiarity, and shared knowledge.
37
38 Subteams could result in an ingroup preference, based on social identities, which could
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40 strengthen internal knowledge application within the team while weakening knowledge transfer
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42 across subteams (Messick & Mackie, 1989). We coded each dyadic relationship if it occurred
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44 within or outside of the subteam to control for such social identities and in-group preference (0
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46 indicating the same team, 1 indicating a different team).
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50 Members who are mutually acquainted should have acquired a more accurate understanding
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52 of each other’s task mental models through their previous interaction (Moreland, 1999).
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54 Participants were asked to rate their familiarity with all others on by responding to “How well do
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4 you know the following person (name)?" on a four-point scale from 1 (do not know) to 4 (know
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6 very well).

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8 Shared knowledge can also affect knowledge application because the cost (e.g., time and
9
10 effort to explain knowledge) of transferring knowledge between the source and receiver is lower
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12 in similar dyads; various demographic indicators such as gender, nationality, and functional
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14 background can suggest overlapping knowledge acquired through common experience (Reagans
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16 & McEvily, 2003). Hence, we created a dummy variable to control for these effects on
17
18 knowledge application and cross-understanding. The same nationality, gender, and function of
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20 the source and receiver of the knowledge were coded as 0, otherwise as 1. This is indicated in the
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22 Tables 2 and 3 as national, gender, and functional diversity.
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29 Results

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31 Correlation and descriptive statistics are shown in Table 2. The correlation table should be
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33 examined with caution since the raw correlations and significance shown in the tables do not
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35 account for the dependent nature of the observations (Quigley *et al.*, 2007). However, we note
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37 that the multicollinearity between the predictor variables are within the acceptable level with a
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39 variance inflation factor (VIF) of 1 (Field, 2009).
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45 ***Insert Table 2 here***
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49 To test the hypotheses, we estimated linear mixed effects model using SPSS. The data we
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51 collected were nonreciprocal, because we collected only from the respondent perspective, and
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53 each respondent reported on multiple communication relationships (Kenny & Cook, 1999). This
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research design requires multilevel modelling (Kenny *et al.*, 2006), because having multiple observations from individual respondents violates the independence assumption of ordinary least squares regression (Kenny *et al.*, 2006). To control for this dependence structure, we employed a linear, mixed-effects model with a random intercept (Kenny *et al.*, 2006).

In order to test hypotheses, we used a mediated regression approach (Baron & Kenny, 1986), in which three separate regression equation models with random intercept are examined. First, in model 1, the mediator (cross-understanding) was regressed on the independent variable (analogy and communication frequency) and control variables. In the second model, the dependent variable (knowledge application) was regressed on the independent variable and control variables. In the third model, the dependent variable was regressed on the independent variable, the mediator, and the control variables.

Table 3 shows the mediated regression results for models 1 through 3. In model 1 and 2, we entered the control variables in step 1, before entering communication frequency in step 2. Because we theorized analogies to have the strongest effect, we entered it last (step 3). In model 1, two (gender, $p < 0.05$; and functional diversity $p < 0.05$) of the five control variables in the model showed a significant relationship with cross-understanding. The coefficient of analogy ($p < 0.05$) and communication frequency were positive and significant ($p < 0.01$), supporting Hypotheses 1 and 3. In model 2, none of the control variables had a significant relationship to knowledge application. Further, the coefficient of analogy ($p = 0.001$) was significant and in the intended direction. However, communication frequency had non-significant relationship to knowledge application, failing to support Hypothesis 6.

Insert Table 3 here

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6 Entering the mediator cross-understanding in model 3 improved the overall model
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8 significantly ($p < 0.01$). Of the control variables, only team membership ($p < 0.05$) was
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10 negatively related to knowledge application. The use of analogy had a significant positive
11
12 relationship to knowledge application, $F(1, 128.86) = 8.19$, $p < 0.01$ confirming Hypotheses 2.
13
14 Further cross-understanding had a positive relationship to knowledge application $F(1, 143) =$
15
16 17.26 , $p < 0.001$, supporting Hypothesis 4. In addition, the coefficient of analogy was lower in
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18 model 3 than in model 2, providing evidence of the partial mediation effect of cross-
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20 understanding, supporting Hypothesis 5.
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26 Discussion

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28 While previous studies point out the importance of team members communicating effectively
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30 and accurately understanding what other team members know, believe, prefer, and sense, in
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32 order to facilitate knowledge processing in diverse teams (Huber & Lewis, 2010), researchers
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34 have struggled to identify a particular communication mode that facilitates knowledge use in
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36 diverse teams (van Knippenberg *et al.*, 2004). Similarly, the construct of cross-understanding,
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38 offered as a potential mechanism of processing member meaning (Huber & Lewis, 2010), has
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40 not garnered much empirical support (Meslec & Graff, 2015). This study reveals the potential of
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42 analogies as a communication mode for developing cross-understanding and knowledge
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44 application, as well as demonstrating the utility of communication frequency as an antecedent of
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46 cross-understanding.
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51 Supporting hypotheses 1, 2, and 5, the results indicate that analogies may be effective in
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53 increasing cross-understanding and knowledge application, and that cross-understanding
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3 partially mediates the relationship between analogy and knowledge application. The more
4 analogies are used, the higher the level of cross-understanding achieved. It seems linking
5 knowledge domains can enhance the understanding of new ideas and concepts, as well as
6 supporting knowledge application. This extends previous research in which analogies enhance
7 understanding of unfamiliar content of consumer products, innovation, scientific discovery, and
8 new concept development (Kalogerakis *et al.*, 2010; Sifonis *et al.*, 2006).
9

10
11 Analogies had not only an indirect effect on knowledge application, through cross-
12 understanding, but also a direct effect. It seems likely that analogies are a communication **mode**
13 that can enhance knowledge processing and usage in teams. The effectiveness of analogies may
14 depend on its persuasiveness, in line with studies in politics that have shown the power of an
15 analogy in making an argument (Whaley, 1998). The findings also support our hypothesis 4 that
16 cross-understanding had a significant positive relationship with knowledge application seems to
17 demonstrate that having meta-knowledge about team members' knowledge, beliefs, and
18 preferences increases knowledge application.
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20
21 However, we did not find support for Hypothesis 6 that cross-understanding would mediate
22 the relationship between communication frequency and knowledge application. Although we
23 found a positive relationship between communication frequency and cross-understanding,
24 supporting hypothesis 3, communication frequency did not have a significant relationship to
25 knowledge application. This supports our overall contention that communication frequency is not
26 enough to get diverse teams to apply their differential knowledge to their tasks. We believe that
27 while individual team members can improve their cross-understanding through elaborating on
28 the task, sharing beliefs and preferences, knowledge application requires not only that the
29 knowledge is understood but also accepted. This requires that individuals not only objectively
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3 transfer knowledge, but also persuade individuals to apply certain tools or ideas on the problem.
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5 That said, it seems important for team members to communicate at the beginning of project in
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7 order to develop cross-understanding, in line with research on the benefit of member
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9 conversation that elaborates on task-relevant information (Hansen, 1999) and the positive
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11 relationship of communication frequency to development of the transactive memory system
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13 (Lewis, 2004).
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17 Analogies (as the structure of what a team member says to share information and ideas) go
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19 beyond communication frequency (how often something is said). As expected, analogies and
20
21 communication frequency do not correlate. There may be several reasons for this, such that team
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23 members are not often aware of the effectiveness of analogies or experienced in their use. In this
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25 study, the analogies were unprompted, occurring by chance rather than by purpose. Future
26
27 researchers may be interested in controlling or inducing the use of analogies in heterogeneous
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29 team tasks.
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33 Among the control variables, only team membership had a negative relationship to knowledge
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35 application. It could be that strong social identities within the teams resulted in in-group
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37 preference, which may have strengthened internal knowledge sharing (Messick & Mackie,
38
39 1989). Because participants formed their own teams (within guidelines of multiple disciplines
40
41 and national backgrounds), they may have selected members with whom they liked to work.
42
43 Somewhat surprisingly, the control variable of shared knowledge between the dyads did not play
44
45 an important role in cross-understanding and knowledge application. Although transferring
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47 knowledge among dyads with shared knowledge should be easier (Reagans & McEvily, 2003),
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49 controlling for similar demographic factors seemed to have no significant effect. It might be that
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3 these graduate student team members did not yet possess the in-depth expertise that would hinder
4 understanding of those from a different discipline (Hinds & Pfeffer, 2003).
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10 *Limitations*

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12 As with any research, this study has some limitations. First, the sample of graduate students
13 working with a real-world client may limit generalization of the study results to relevance for
14 student team-based projects, because students may operate in a different environment than
15 professionals (Dahlin et al., 2005). This being said, there are parallels to professional
16 workplaces. Student team members averaged 36 months of work experience, and worked on a
17 concept development design project similar to those of professional teams. Furthermore, because
18 relative novices such as students often struggle to effectively use analogies (Forbus *et al.*, 1995;
19 Novick & Holyoak, 1991), a field study might find stronger results.
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31 Second, communication frequency was broadly operationalized. In this study, we asked
32 students to identify with whom they spoke most frequently without asking about the content of
33 this interaction. As a result, we are not able to say if the communication was task, teamwork, or
34 socially related and if these different types of interactions differentially effect cross-
35 understanding and knowledge application. Future research could focus on different types of
36 communication frequency.
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47 **Practical Implications**

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49 This study provides two key practical implications for organizations that employ diverse teams
50 to undertake concept development tasks. First, during a project team members should be
51 encouraged to talk not only about factual and relatively objective knowledge, but also about
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4 member preferences and motivations that relate to the expanded mental model of cross-
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6 understanding. Second, team members should be encouraged to use analogies where appropriate
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8 to structurally link heterogenous content areas to establish cross-understanding, which supports
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10 knowledge application to the task at hand. While individuals may not be aware of the utility of
11
12 analogies in communication, analogy use can be taught (e.g. Wormeli, 2009). Organizations may
13
14 benefit from training team members on analogy use and other communication modes that can
15
16 enhance knowledge processing in the context of teams.
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20 The purpose of this study was to explore the role of analogy use in cross-understanding and of
21
22 knowledge application in diverse design teams. Our results indicate that analogies are relevant
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24 for team processes and thus practitioners and organizational consultants should consider
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26 enhancing the cross-understanding of team members. Future researchers may want to further
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28 validate the analogy and cross-understanding constructs in field settings, and test their
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30 relationships with process variables (e.g., goal orientation). This study is a needed step towards
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32 more research on these important constructs.
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Appendix*Analogy Scale Items*

1. This person describes difficult concepts by comparing them with other concepts from related areas or disciplines (factor loading (FL): .87).
2. This person explains new ideas by linking this idea to something familiar that we both know (FL: .86). *Excluded from the analyses.*
3. This person explains new information by relating it to something I already know (FL: .83).
4. This person comes up with ideas by drawing from existing solutions from different fields (FL: .82).
5. This person uses concepts from other fields and disciplines to understand and solve problems. (FL: .78).

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Figures and Tables

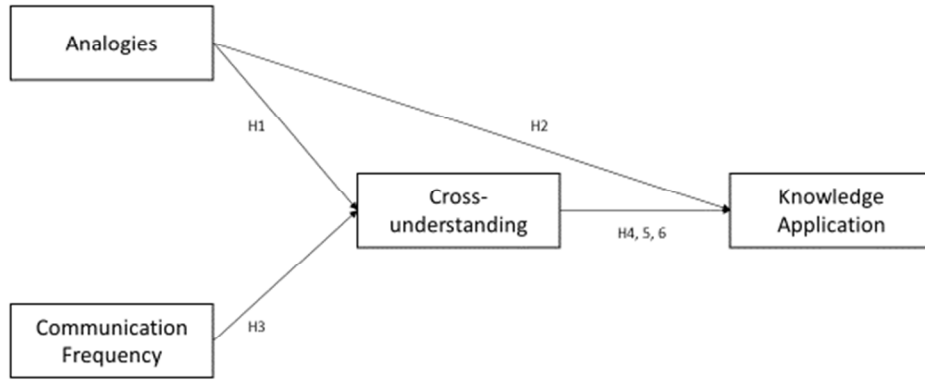


Figure 1. Theoretical Framework

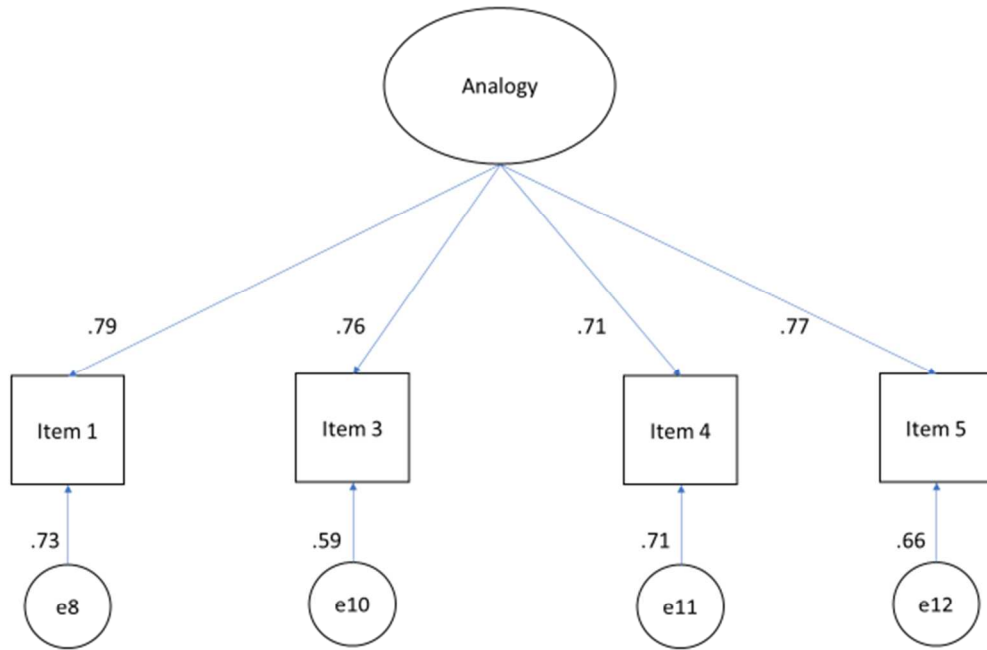


Figure 2. CFA Results

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Table 1.

Demographic Characteristics

	Mean	Median	Mode	SD	Minimum	Maximum
Age	26.579	24.5	23b	4.9080	22	43
Gender	1.447	1	1	.5039	1	2
Work experience	35.868	36	62	23.6519	1	62

Note. a. Sample size 38. b. Multiple modes exist. The smallest value is shown

Table 2.

Means, Standard Deviations, and Correlations of All Variables

	Mean	s.d.	1	2	3	4	5	6	7	8
1 Familiarity	1.71	.78								
2 Team	.34	.48	.18*							
3 Gender diversity	.51	.50	-.16	-.14						
4 National diversity	.69	.46	-.06	-.24**	-.03					
5 Functional diversity	.79	.41	-.26**	-.33**	.00	.09				
6 Analogy	4.92	1.04	.06	.06	-.04	.07	-.06			
7 Communication freq.	5.70	1.26	-.15	-.53**	.08	.02	.25**	.11		
8 Cross-understanding	5.21	.80	.03	-.08	-.14	.06	-.11	.22**	.30**	
9 Knowledge Application	5.74	1.04	-.08	-.22**	.02	.21*	.01	.29**	.23**	.44**

Note. The correlation table should be examined with caution since the observations are dependent.

N = 146. * p < .05, ** p < .01

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Table 3.

Relationship of Communication Frequency & Analogy to Knowledge Application via Cross-understanding.

Variable	Model 1 (analogy, communication frequency → cross-understanding)			Model 2 (analogy, communication frequency → knowledge application)			Model 3 (analogy, communication frequency & cross-understanding → knowledge application)
	Step 1	Step 2	Step 3	Step 1	Step 2	Step 3	Step 4
Intercept	5.84***	4.49***	4.06***	6.23***	5.62***	4.58***	2.83***
Familiarity	-.06	-.06	-.07	-.11	-.11	-.15	-.12
Team	-.09	.22	.17	-.41**	-.27	-.34	-.41*
Gender diversity	-.20	-.21*	-.21*	-.10	-.10	-.08	.01
National diversity	-.23	-.12	-.15	.01	.06	.01	.09
Functional diversity	-.27*	-.32*	-.31*	-.09	-.11	-.08	.05
Communication frequency		.21***	.17**		.09	.03	-.04
Analogy			.14*			.30***	.24**
Cross-understanding							.42***
χ^2	305.25	289.03	279.90	373.60	371.74	353.22	337.02
Change of χ^2		16.22**	9.13**		1.86	18.52**	16.02**

Note. N = 146. * p < .05, ** p < .01, *** p < .001