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Cognitive Mechanisms Underlying the Engineering Students' Desire to Cheat During Online and Onsite Statistics Exams

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Abstract: A sample of 327 engineering bachelor students from a public university in Mexico took part in an information integration study to explore systematic thinking underlying propensity for cheating during a course exam. All study participants were provided with written descriptions of 12 scenarios pertaining to the academic evaluation criteria and were asked to rate the likelihood that they would cheat under such circumstances. The 12 scenarios reflected the experimental manipulation of three orthogonal factors: teacher's teaching style, type of exam, and modality of assessment. Analysis results revealed four distinct attitudes toward cheating among students, two of which were independent of context (low and high desire to cheat) while the remaining two were context-dependent (low and moderate desire to cheat). All groups showed systematic thinking underlying their possible desire to cheat that was typified by the use of a summative cognitive rule for integrating information related to academic cheating. However, evaluation of factor relevance varied across the groups.

Keywords: *Propensity for academic cheating, learning evaluation, online, face-to-face evaluation, and cognitive algebra.*

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Introduction

Cheating is a frequent human behaviour that is exhibited in almost all life contexts (Green, 2004), and is particularly practiced in business (e.g., Graves & Austin, 2008), marriage (e.g., Ogwokhademhe & Ishola, 2013), store purchases (Mazar, Amir, & Ariely, 2008), encounters with law enforcement (e.g., Nyblade & Reed, 2008), or in educative environments (Gallant, Einde, Ouellette, & Lee, 2014; Lee, 2009).

Given its high prevalence and growing opportunities for cheating in academic context, it is considered as one of the most serious problems affecting educative institutions throughout the world (Hsiao, 2015; Miller, Agnich, Posick, & Gould, 2015). Academic misconduct is harmful during assessments, as those that cheat not only deceive themselves, but also impede teachers in effectively monitoring their learning progress and providing accurate feedback (Anderman & Murdock, 2007). In more formal exam settings, academic cheating allowed students to obtain certification that does not reflect their actual achievements (Harding, Carpenter, Finelli, & Passow, 2004). In sum, academic cheating has negative implications from both personal and institutional educational perspective (student quality, institution image, etc.).

Findings yielded by extant studies suggest that academic cheating is a strong predictor of corruption in formal work settings (Harding et al., 2004; Jarc, 2009; Nonis & Swift, 2001; Rujoiu & Rujoiu, 2014). Propensity for cheating has particularly significant implications for professional services where people's wealth or even their lives depend on career certification (medical services, legal services, etc.).

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Yet, despite negative implications of academic dishonesty, 45–90% of bachelor students admitted to cheating (e.g., International Center for Academic Integrity [ICAI], 2017; McCabe, 2005; Smyth & Davis, 2004) or reported seeing this behaviour in their schoolmates (Saana, Ablordeppey, Mensah, & Karikari, 2016; Smyth & Davis, 2004).

Generally speaking, academic dishonesty pertains to any non-authorised or unethical behaviour (Park, Park, & Jang, 2013) that leads to fraudulent performance (Whitley, 1998). Within educative settings, there is a wide range of possibilities to cheat, such as copying during exams, resorting to plagiarism, reporting fake results, being an imposter during testing, reporting false clinical reports, etc. (Agud, 2014).

Nowadays, the introduction of new education technologies has widened the possibilities for deceitful behaviours in academic settings. For instance, students can now resort to simple online plagiarism (e.g., discretely copying notes from another student) as well as dishonest organised sharing of academic work by multiple students via websites (e.g., O'Shaughnessy, 2011). Indeed, many other possibilities are available for e-cheating if a student has enough technological knowledge to access authorised databases or documents by using simple mobile electronic devices (e.g., tablets, computers) or e-mail, websites, chat rooms, and text messages (Campbell, 2006; Ma, Wan, & Lu, 2008).

Different approaches and instruments have been used to deepen our knowledge on the nature of dishonest academic behaviour. For instance, self-reports (e.g., Burrus, McGoldrick, & Schuhmann, 2007; David, 2015), controlled observation of cheating behaviour in laboratory tasks (Fosgaard, Hansen, & Piovesan, 2013; Rettinger & Kramer, 2009), questionnaires (e.g., Koul, 2012), by using scales (e.g., Orosz et al., 2016), interviews (Bachore, 2016), experimental designs (Kanat-Maymon, Benjamin, Stavsky, Shoshani, & Roth, 2015), considering secondary school samples (Anderman & Midgley, 2004; Orosz et al., 2016), university samples (Arnold, 2016; Ballantine, McCourt Larres, & Mulgrew, 2014), considering onsite assessment of learning (e.g., Hsiao, 2015) and online assessment of learning (Arnold, 2016; Bain, 2015; King & Case, 2014), etc. Such research has been conducted in a wide variety of countries, including Spain (e.g., Agud, 2014), Hungary (e.g., Orosz et al., 2016), Ireland (Ballantine et al., 2014), Malaysia (e.g., Shariffuddin & Holmes, 2009), Mexico (e.g., Ayala-Gaytan & Quintanilla-Dominguez, 2014), and the USA (e.g., Campbell, 2006), among others.

The insights gained from these academic efforts have revealed a set of factors underlying dishonest behaviour in educative environments that include student profile (e.g., demographic characteristics, personality traits, attitudes, academic beliefs, agency mechanisms, motivation), contextual factors (e.g., culture) and situational factors (e.g., social pressure, teaching style, etc.), which are discussed in more detail in the following section.

Factors Underlying Academic Dishonesty in Students

The aforementioned research studies provide support for the idea that demographic attributes such as age and gender relate to academic dishonesty (Rawwas, Al-Khatib, & Vitell, 2004) as they determine the degree of its acceptability (Ballantine et al., 2014). For example, empirical evidence indicates that women are more intolerant to cheating behaviour than men (DeAndrea, Carpenter, Shulman, & Levine, 2009). However, this is not a generalisable result, as David (2015) did not find significant differences between males and females regarding cheating behaviour. However, he found that self-esteem and self-control negatively correlated with cheating.

Additional research indicates that goal-oriented behaviours (learning versus academic performance) affect strategies adopted for academic success. Since cheating can be considered a strategy aimed at attaining success, this behaviour can be affected by students' goals. For example, Anderman and Danner (2008) showed that students that see knowledge acquisition as their primary aim are less prone to cheat than students focused solely on academic performance. However, this is not the case under all circumstances.

While agency variables (e.g., locus of control) are insufficiently explored, Kanat-Maymon et al. (2015) found that when students felt less control over an academic outcome, less interest from teachers in them as persons, and less confident in their academic performance they were willing to act dishonestly in performing mathematics or solving arithmetic problems. These results give support to the locus of control hypothesis stipulating that external non-controllable academic situations might lead some students to dishonest academic behaviour (Pino & Smith, 2003).

Additional contextual factors (e.g., fraternity sense, classmates behaviours) and situational considerations (e.g., modality of learning assessment) are also related to dishonest behaviour. For example, David (2015) argued that if cheating is a common practice within a group of students, individuals are more likely to act dishonestly. Rationale underlying this behaviour might be related to social pressure (Whitley, 1998). In addition, it has been observed that students' perceptions of a teacher, as well as the relationship between the teacher and the students, inhibit or facilitate students' willingness to act dishonestly. For instance, Boysen (2007) reported in his doctoral dissertation that unorganised permissive teaching style is one of the reasons for students' to cheat.

In regard to situational considerations, it has been reported that evaluation type and modality of evaluation might affect dishonesty rates. For example, Dodeen (2012) found that students are more likely to resort to cheating when testing instruments include multiple choice answers than if a test includes open questions. Moreover, if online assessment is required, Ma et al. (2008) suggested that willingness to cheat increases. However, other authors have argued that willingness to cheat might also depend on the amount of teachers' supervision during evaluation (Harmon & Lambrinos, 2008; Stack, 2015). That is, testing modality affects students' behaviour only under some circumstances.

Another variable related to academic cheating are students' antecedents, suggesting that experience might modulate academic dishonesty (Ordonez, Mejia, & Castellanos, 2006). Similarly, personality traits like procrastination (Sureda-Negre, Comas-Forgas, & Oliver-Trobat, 2015), morality (Iorga, Ciuhodaru, & Romedea, 2013), narcissism (Brunell, Staats, Barden, & Hupp, 2011), attitudes toward cheating (Kayisoglu & Temel, 2017), and students' idealism (Ballantine et al., 2014) are among the variables that may affect honest behaviour.

Current research on this topic has revealed several possible behavioural factors underlying academic dishonesty. However, cognitive specification on how these factors can be integrated to produce academic dishonesty remains unexplored. In the present study, it is argued that by using a cognitive algebra paradigm derived from the information integration theory significant contributions can be obtained to deepen our knowledge of the reasons behind academic dishonesty. A cognitive algebra study is presented next, in line with this academic intention.

Information Integration Theory as a Cognitive Method for Exploring the Nature of Academic Dishonesty

Information integration theory (IIT) proposes that, for a person to make a judgment she/he first selects what he/she considers relevant pieces of information from the environment to realise the cognitive task. After imposing a meaningful psychological interpretation to these pieces of information, an individual will systematically integrate these valued sources of information by using cognitive algebraic rules to produce a unified judgment response (Anderson, 1991). Figure 1 depicts how this cognitive idea might be extrapolated to situations involving academic dishonesty. Within this context, a student will select relevant pieces for cheating from sources of information available in the educative context (S), after which he/she will impose psychological valuation on those sources of information (Ψ_1). These sources of information are subsequently systematically integrated through a psychological function (ρ), to finally produce a dishonest behaviour (R). By considering this cognitive specification schema, this research aims to determine the way students take the decision to cheat by analysing psychological valuation (V) as well as to cognitively specify algebraic integration of information (I operator) in order to put under scrutiny the observed cheating behaviour (R).

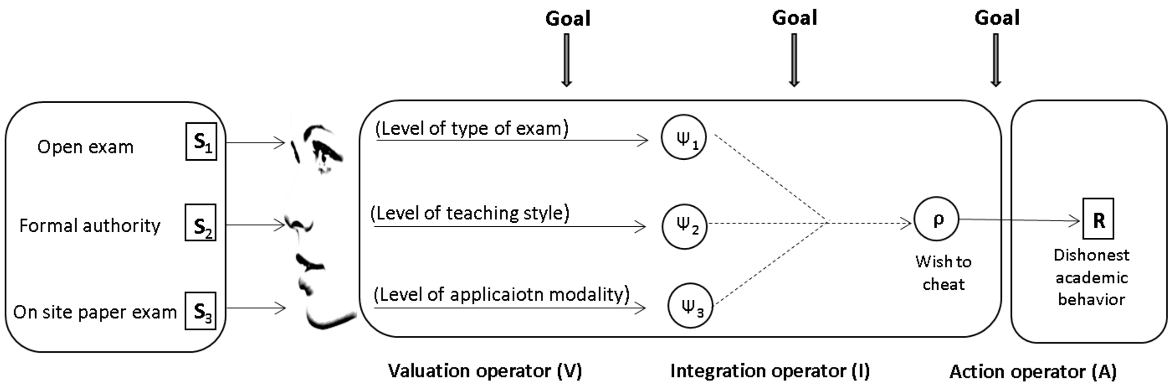

Figure 1. Information integration diagram describing a possible case of academic dishonesty.

Three cognitive serial processes (V–I–A) follow an initial personal perception of available stimuli (S). This chain of cognitive events might lead to an observable response (R) (Modified from Anderson, 1991).

The cognitive algebra paradigm has been used to explore a variety of human behaviour domains (Castro, Morales, Lopez, Olivares, & Masip, 2018; Esterle, Munoz-Sastre, & Mullet, 2008; Falconi & Mullet, 2003; Herve, Mullet, & Sorum, 2004; Morales, 2012; Morales-Martinez, Lopez- Ramirez, Esterle, Munoz-Sastre, & Mullet, 2010), including special education (e.g., Morales, Lopez, Villarreal-Trevino, Montalvo, Mezquita-Hoyos, & Castro-Sanchez, 2014), technical education for work settings (e.g., Morales-Martinez, Lopez-Ramirez, Villarreal-Trevino, & Mezquita-Hoyos, 2015) and academic self-efficacy in middle education (e.g., Briones-Rodriguez, Morales-Martinez, Santos-Alcantara, Lopez-Ramirez, & Urdiales-Ibarra, 2016) and higher education (e.g., Villarreal-Trevino, Villarreal-Lozano, Morales-Martinez, Lopez-Ramirez, & Flores-Moreno, 2017). However, academic dishonesty has never been explored from an IIT perspective, and the goal of this research is to introduce this approach in the field of academic dishonest behaviour by answering the question: What are the cognitive information integration mechanisms that might lead to academic cheating?

Framing the Current Study in the Context of Academic Dishonesty

Researchers have examined academic dishonesty in a variety of contexts, including medicine (Kusnoor & Falik, 2013; Rancich et al., 2016), nursing (Macale et al., 2017; Park et al., 2013; Smedley, Cradwford, & Cloete, 2015), business management (Iberahim, Hussein, Samat, Noordin, & Daud, 2013; Tsui & Ngo, 2016), engineering (Vieyra, Strickland, & Timmerman, 2013; Yeo, 2007), psychology (Owens & White, 2013), etc. Findings yielded by these studies indicate that higher propensity for academic dishonest behaviour can be found among engineering students (Harding et al., 2004) and business students (Gallant et al., 2014; Passow, Mayhew, Finelli, Harding, & Carpenter, 2006). However, since there is not enough academic research background regarding engineering students academic cheating (Harding et al. 2004; Passow et al. 2006) little is known about cognitive nature of this cohort´s cheating behavior.

Consequently, another academic interest in this study it to provide information regarding the underlying cognitive mechanism of Cheating Desire during Academic Evaluation (CDAE). The study was conducted on a Mexican sample since the Corruption Perception Index provided by the Transparency International in 2018 indicates that Mexican institutions are among the organisations with higher degrees of corruption. It is within this particular social context (Latin America) that uncovering the cognitive nature of academic dishonesty has major social implications. In the specific case of Mexico, however, academic dishonesty has rarely been examined from scientific perspective (Medina & Verdejo, 2016). Most of the extant work on this topic is based on Likert scales (e.g., Ayala-Gaytan & Quintanilla-Dominguez, 2014) and questionnaires (e.g., Ibarra, Guerrero, & Mercado, 2017). There are some valuable documents based on reflections that contain important behavioural records (e.g., Borromeo, 2017). Due to these approaches to the study of academic dishonesty, experimental research reported here is a valuable addition to the field.

Methodology

Research Goal

A cognitive algebra study was carried out to explore CDAE a sample of engineering students in Mexico. The goal was to determine if systematic thinking is used by this population before resorting to academic dishonesty in either onsite or online assessment environments.

Study Design

A three-factor within-subject experimental design was adopted for the present study, namely 2 (Teaching style: authoritative vs. delegator) × 2 (Test type: open vs. closed) × 3 (Testing modality: face-to-face paper evaluation vs. face-to-face electronic evaluation vs. online evaluation). This resulted in 12 experimental conditions, each representing a possible cheating scenario (see Appendix).

Instruments and Material

The cognitive algebra instrument: Based on the factor manipulation adopted in the study, 12 scenarios were created, each describing a hypothetical learning assessment situation. In addition, measurements of some students' personal variables (motivational and attributional) that are associated with academic dishonesty (goal-oriented behaviour and locus of control) were obtained by using two scales, namely the goal-oriented behaviour scale (Button, Mathieu, & Zajac, 1996) and the Internality (I), Powerful Others (P) and Chance (C) Levenson scale (Levenson, 1981).

Goal oriented behavior: The goal-oriented behaviour scale developed by Button et al. (1996) was used in this study. This instrument is intended to provide information about students' tendencies to achieve self-learning goals as well as information about their academic performance concerns. This scale consists of two sub-scales—the Performance Goal Orientation (PGO) and the Learning Goal Orientation (LGO) scale—each consisting of ten items, which are rated on a seven-point Likert-type scale ranging from 1 (strongly disagree) to 7 (strongly agree). According to Simmons (2013), scores for each scale are obtained by simple addition of pertinent item values. A high score in PGO suggests that an individual has a strong desire to perform better than others, i.e., the person has inclination to seek favourable opinions about her/his academic competencies. On the other hand, high LGO scores emphasise desire to master a specific academic ability.

Button et al. (1996) validated this scale by applying it to a sample of 374 students. He obtained a Cronbach alpha value of .76 for the PGO subscale and .79 for the LGO scale. It is important to note that, in the present study, a Spanish version of the scale was validated by administering the instrument to 673 Mexican undergraduate students. Here, Cronbach alpha values were.76 and .87 for the PGO and LGO subscale, respectively. According to Simmons (2013), prior to 2013, no translations of this scale to other languages were available.

Locus of control: In order to measure students' perception of control over the external aspects of their lives, the Internality (I), Powerful Others (P) and Chance (C) Levenson scale (or IPC Levenson scale) was adopted in this study. This scale consists of three subscales, one of which is the *internal subscale* that measures a person's perception of control she/he has over his/her life. The *powerful others subscale*, on the other hand, measures the belief a person has about others controlling her/his life. Finally, the *chance subscale* is intended for measuring participants' expectation of life events occurring only by chance. Responses are given on a 6-point scale anchored at -3 (strongly disagree) and +3 (strongly agree) to obtain locus of control scores. The final scoring for each subscale is obtained by simply adding individual scores in each scale and then adding to this value 24 additional points to eliminate negative signs. Thus, the values for each scale can vary between 0 to 48 points (Levenson, 1981).

Levenson (1974) validated his scale by taking into account 152 students. He reported a reliability score of .64 for the "I" subscale, a .77 for the "P" subscale and .78 for the "C" subscale. A Spanish version was validated for the present study by administering the instrument to 696 bachelor students, yielding a KR-20 value of .70 for the "I" subscale, .84 for the "P" subscale, and .89 for the "C" subscale.

Social desirability scale: Social desirability was considered as a control variable in the present work. For this purpose, study participants were required to complete the Marlowe-Crowne Social Desirability Scale (Crowne & Marlowe, 1960), comprising of 33 items, each requiring a false/true response. Creators of the scale reported a reliability score of .88 (Kuder-Richardson formula 20 or KR-20). In this study, a reliability score of .83 was obtained when the Spanish version of the instrument was administered to a sample of 635 bachelor students.

Participants

The study sample comprised of 327 engineering bachelor students, 100 (31%) of whom were female, and 227 (69%) were male. Their age varied between 17 and 27 years (M = 19.22, SD = 1.4). Moreover, 82% of the participants stated that they were religious people, and 14% of this group noted that they constantly practice their religion, whereas the others practiced irregularly. Participation in the study was voluntary and all participants obtained credit course points for their effort.

Procedure

Students were invited to participate in this study by posting a Facebook message to 600 individuals, 327 of whom responded to the invitation and completed the study. After informed consent was obtained from the study participants, they took part in a practice session in order to get familiar with online instruments. Once they reported full comprehension of the digital experimental task, they were instructed to continue with the study, which consisted of reading randomly presented 12 scenarios one by one and providing a judgment toward CDAE. The time taken to complete the study ranged from 15 to 20 minutes.

Findings / Results

The obtained raw data was subjected to ANOVA statistical analysis, having in mind the experimental design of 2 (Gender: male vs. female) × 2 (Teaching style: authoritative vs. delegator) × 2 (Test type: open vs. closed) × 3 (Testing modality: face-to-face paper evaluation vs. face-to-face electronic evaluation vs. online evaluation). Statistical significance criterion was set to $p < .001$.

Analysis results showed that the CDAE mean score was significantly higher for men (M = 3.51, SD = 2.81) than for women (M = 2.48, SD = 2.59), $F(1, 325) = 9.837$, $p < .001$, partial $\eta^2 = .02$. No significant factor interactions were observed (Figure 2) but selection of factors depended on the student's gender. For women, the most relevant factors related to exam modality ($F(1, 198) = 35.26$, $p < .001$, partial $\eta^2 = .26$) and exam type ($F(1, 99) = 11.811$, $p < .001$, partial $\eta^2 = .10$) whereas for men the most relevant factors were exam modality ($F(2, 452) = 115.656$, $p < .001$, partial $\eta^2 = .33$), exam type ($F(1, 226) = 56.785$, $p < .001$, partial $\eta^2 = .20$) and teaching style ($F(1, 226) = 15.252$, $p < .001$, partial $\eta^2 = .06$).

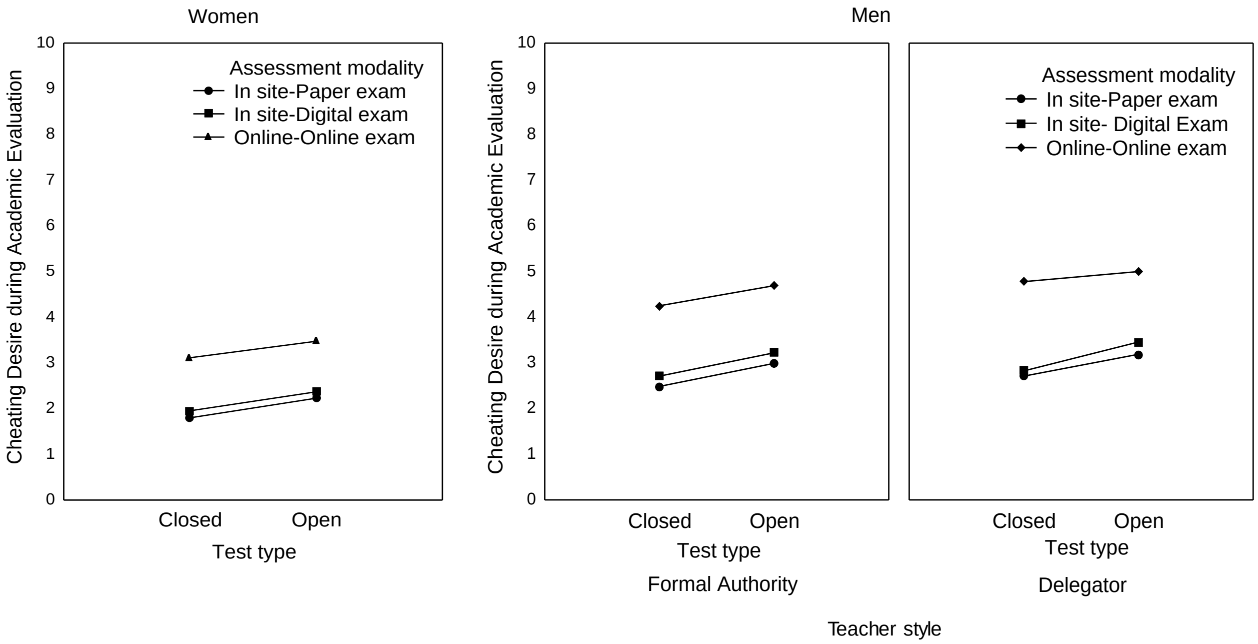

Figure 2. Interaction ANOVA Graph showing most relevant factors. The left panel shows data patterns for female participants, whereas the two most right panels show data patterns for male participants.

Both groups showed a wide range toward CDAE (from 0 to 10). Considering this variation, and independently of gender factor selection differences, the factor interaction pattern was similar for males and females. Thus, a cluster analysis was carried out on all participants' responses (means-K, Euclidean distances; Hofmans & Mullet, 2013) to further elucidate the variability in the CDAE value ranges, aiming to identify more than one path that would lead to toward CDAE.

Cluster Analysis

Four response patterns could be identified in the students' responses, irrespective of their gender (η^2 = .92). The first pattern of responses allowed us to identify a group of students (n = 103, 31%) with a low CDAE index (Range: = -1.58, M = .49, SD = .46). This was independent of evaluation circumstances, such as teaching style or modality of assessment. For this group, it was inadmissible to cheat during learning evaluation. The second group (n = 97, 30%) comprised of students whose CDAE values were relatively low (Range: 1–3.3, M = 2.1, SD = .55) and circumstances-dependent. The third cluster (n = 49, 15%) consisted of students who had low to moderate CDAE values (Range: 2–6, M = 4.1, SD = .94) that were also dependent on the circumstances surrounding the assessment. In this group, modality of assessment was the most relevant factor. The final cluster (n = 78, 24%) consisted of students with high CDAE values (Range: 6–10, M = 7.5, SD = 1) that are independent of circumstances surrounding evaluation of learning.

ANOVA for each Cluster

For each cluster, a repeated measures ANOVA was carried on by considering the experimental design of 2 (Teacher style: authoritative vs. delegator) × 2 (Test type: open vs. closed) × 3 (Testing modality: face-to-face paper evaluation vs. face-to-face electronic evaluation vs. online evaluation). Significance criterion was set to $p < .001$.

As indicated in Table 1, assessment modality was the most relevant factor for all four clusters, followed by the type of exam (Cluster 1, 2, and 3), while the teaching style was only relevant for Cluster 4. In addition, the statistical analysis showed no significant interactions among study factors for any cluster. Most importantly, data patterns followed an information integration rule, which was the same for all clusters (Figure 3).

Table 1 . ANOVA Results for Each Cluster

Source	***df***	***MS***	***df***	***MS***	**F**	***p***	***η²***
Cluster 1 (n = 103, M_{CDAE} = .49, SD_{CDAE} = .46)							
<<Very low desire to cheat independently of circumstances**>>**							
Teacher style (S)	1	1.230	102	0.614	2.002	ns	.019
Test type (T)	**1**	**7.612**	**102**	**0.679**	**11.203**	**.001**	**.098**
Testing modality (M)	**2**	**22.728**	**204**	**0.921**	**24.657**	**.001**	**.194**
S*T	1	0.680	102	0.319	2.130	ns	.020
S*M	2	1.065	204	0.425	2.507	ns	.023
T*M	2	0.340	204	0.388	0.877	ns	.008
Cluster 2 (n = 97, M_{CDAE} = 2.1, SD_{CDAE} = .55)							
<<Very low desire to cheat but dependent on circumstances**>>**							
	df	***MS***	***df***	***MS***	**F**	***p***	***η²***
Teacher style (S)	1	8.083	96	2.378	3.398	ns	0.0341
Test type (T)	**1**	**99.897**	**96**	**2.717**	**36.764**	**.001**	**.276**
Testing modality (M)	**2**	**331.131**	**192**	**4.238**	**78.129**	**.001**	**.448**
S*T	1	1.739	96	2.427	0.716	ns	.007
S*M	2	0.222	192	1.848	0.120	ns	.001
T*M	2	0.665	192	1.144	0.581	ns	.006
Cluster 3 (n = 49, M_{CDAE} = 4.1, SD_{CDAE} = .94)							
<<Moderate desire to cheat, dependent on circumstances**>>**							
	df	***MS***	***df***	***MS***	**F**	***p***	***η²***
Teacher style (S)	1	19.108	48	4.844	3.944	ns	.075
Test type (T)	1	41.387	48	5.484	7.545	ns	.135
Testing modality (M)	**2**	**1789.542**	**96**	**6.775**	**264.133**	**.001**	**.846**
S*T	1	1.333	48	3.375	0.395	ns	.008
S*M	2	11.777	96	3.836	3.069	ns	.060
T*M	2	2.943	96	3.728	0.789	ns	.016
Cluster 4 (n = 78, M_{CDAE} = 7.5, SD_{CDAE} = 1)							
<<High desire to cheat, dependent on circumstances**>>**							
	df	***MS***	***df***	***MS***	**F**	***p***	***η²***
Teacher style (S)	**1**	**51.240**	**77**	**4.697**	**10.908**	**.001**	**.124**
Test type (T)	**1**	**84.360**	**77**	**4.704**	**17.932**	**.001**	**.188**
Testing modality (M)	**2**	**71.115**	**154**	**5.442**	**13.067**	**.001**	**.145**
S*T	1	0.565	77	2.190	0.257	ns	.003
S*M	2	0.730	154	2.869	0.254	ns	.003
T*M	2	4.799	154	2.474	1.939	ns	.024

*Significance criterion $p < .001$ $n = 327$

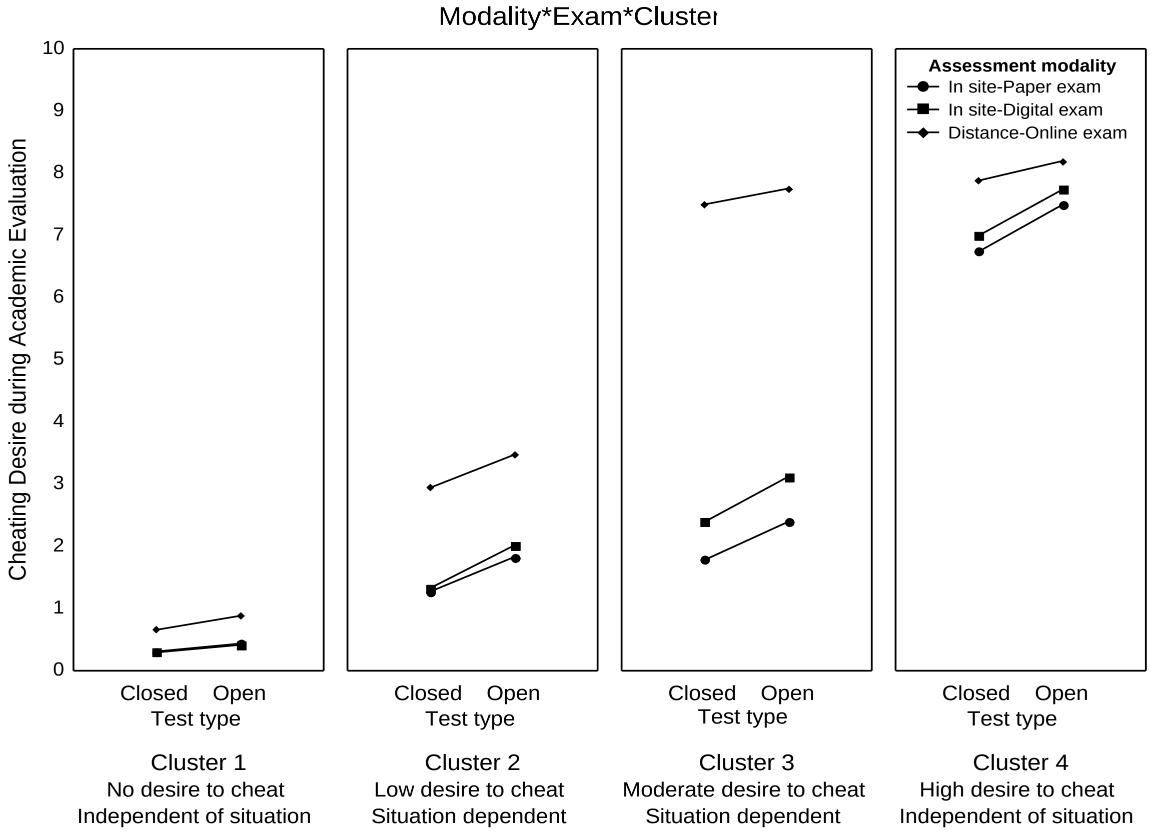

Figure 3. Interaction graph showing the data pattern relation between the two most relevant factors (assessment modality vs. exam type) for the four identified clusters.

Furthermore, a one way ANOVA was carried on to determine if cluster differences could be found regarding internal locus of control (ILC), the locus of control due to others (LCO), the random locus of control (RLC), the goal oriented performance factor (GOP), the goal oriented to learning behaviour factor (GOL), or social desirability (SD). Here data provided evidence for significant differences among clusters regarding type of locus of control, the kind of goal-oriented behaviour and social desirability. A Bonferroni post hoc analysis was carried on over these Cluster differences by considering 279 participants´ raw data. This so, since not all participants completed all study subscales.

Specifically, the obtained results showed that the mean "P" value was significantly lower in Cluster 1 (M = 12.3, SD = 6.7) than in Cluster 3 (M = 16.2, SD = 6.2) and Cluster 4 (M = 17.2, SD = 8.2), F(1, 325) = 9.837, p =.001, partial η^2 = .02. A similar result was obtained for "C," as the Cluster 1 mean value (M = 14, SD = 6.1) was significantly lower than that obtained for Cluster 3 (M = 17.6, SD = 5.4) and Cluster 4 (M = 18.2, DE = 6.8), F(3, 275) = 5.627, p = 0.0009, partial η^2 = .05. Regarding the PGO mean value, it was significantly lower for Cluster 1 (M = 49.2, SD = 9.3) than for Cluster 4 (M = 52.5, DE = 9.6), F(3, 275) = 3.658, p = .012, partial η^2 = .03. In contrast, the LGO mean value for Cluster 1 (M = 62.8, DE = 5.1) was significantly higher than that pertaining to Cluster 4 (M = 59.2, SD = 9.5). Moreover, the DS average value in Cluster 1 (M = 21.1, DE = 4.7) was significantly higher than the mean value for Cluster 4 (M = 17.5, SD = 4.7), F(3, 275) = 7.319, p = 0.000, partial η^2 = .07.

Relationship between CDAE and other Variables

A Pearson correlation analysis was carried out for CDAE and life control (internal or external agency) and students' orientation towards learning (goal-oriented behaviour towards performance or knowledge acquisition). Here, the results showed a low but statistically significant positive correlation among CDAE and "P," r(279) = .28, p = .001, as well as "C," r(279) = .23, p = .001, and PGO, r(279) = .18, p = .002. In addition, CDAE and DS were negatively correlated, r (279) = -.25, p = .001, while no correlation was obtained between CDAE and "I."

Discussion

This study aimed to explore the cognitive specification of academic dishonesty during assessment of learning (CDAE) based on different environments (onsite vs. online assessment). The first step was to identify the CDAE levels in engineering students, which was followed by the determination of factors underlying CDAE during learning evaluation and the way students integrated information.

Analysis results revealed that, under some circumstances, 96% of study participants (Cluster 2, 3, and 4) experienced desire to cheat. As can be seen from Table 1, CDAE can vary from low to high values, supporting prior research indicating that most students have considered or have been involved in academic dishonesty (see ICAI, 2017; McCabe, 2005; Smyth & Davis, 2004). Furthermore, the present study findings revealed that women were significantly less prone to academic dishonesty. However, only 31% of the current sample comprised of female students. Thus, higher female participation in this type of studies might lead to greater precision regarding the link between gender and CDAE.

Another noteworthy result was that modality of assessment emerged as the strongest factor contributing to CDAE. This is interesting because in all scenarios in which absence of a teacher was implied (e.g., online assessment), the CDAE significantly increased in all groups. This might be related to a student's perception of supervised evaluation rather than a modality of assessment. Indeed, Harmon and Lambrinos (2008) as well as Stack (2015) found that online learning environments relax students' moral judgment, making them more prone to cheating during tests (e.g., Ma et al., 2008). A possible relation between supervision and desire to cheat might imply that a cognitive mechanism requiring an external human actor mediates cheating or dishonest academic behaviour.

The second most relevant factor in the study relates to the exam type. Here, engineering students reported that open exams made them more prone to cheat. However, according to Dodeen (2012), this is not the case, as this author found that closed exams with multiple-choice questions were greater facilitators of inappropriate academic behaviour. These different opinions might be related to the specific engineering students' knowledge domain.

Techers' teaching style also played a relevant role, but only for Cluster 4 (the group with higher CDAE values). This is also interesting, since this group reported the highest external locus of control. That is, these students are of view that their life events depend to a great extent on the actions of others. Some research suggests that whenever students experience less control over a assessment context they tend to cheat (e.g., Pino & Smith, 2003).

On the other hand, students with high desire to cheat (Cluster 4) reported a significantly higher desire to achieve academic rewards and a significantly lower tendency to learn as a means of acquiring new knowledge. This result supports findings yielded by extant studies, suggesting that students that are oriented to strive for academic achievements have a higher tendency to cheat compared to students who see learning as their major goal (e.g., Anderman & Danner, 2008).

Regarding the cognitive mechanism used by study participants to integrate relevant pieces of information, irrespective of the cluster, students tended to use a cognitive summative rule, even though the data suggests that factor valuation was different in each group (see Table 1 and Figure 3). A first cognitive evaluation pattern shows a tendency to CDAE no matter the circumstances. The second and third evaluation patterns, on the other hand, indicate that students' propensity for cheating depends on the assessment modality. Whenever the modality implied lesser teacher supervision, students were tempted to cheat. Finally, there is the case where some students see no justification for academic cheating.

Conclusion

This study contributes to the theoretical understanding of academic dishonesty by identifying cognitive integration rules underlying desire to cheat. First, the results reported in this work support extant research suggesting that CDAE can vary across populations and circumstances. In addition, the nature of the assessment (modality and type of exam) is a relevant information to consider when determining the likelihood of cheating. In particular, students with low and moderate academic cheating desire are more likely to cheat in certain situations, such as in unsupervised assessments.

Furthermore, as a part of the present study, a possible link between academic dishonesty and agency mechanisms was explored. The findings indicate that external agency and external motivation behind learning seemed to jointly influence CDAE. This result seems to indicate that students with external locus of control that are primarily motivated by the need to obtain higher grades could deem CDAE necessary.

Another important aspect was the contribution regarding valuation processes of factors considered to possible deceiving behaviour. Even more cognitive specification is possible on how these valuation processes might vary across different clusters even though the cognitive algebraic summative rule was similar for all groups. This finding suggests that cognitive mechanisms underlying CDAE integrate information in a summative way.

Thus, by considering the cognitive algebra paradigm, relevant contributions were obtained, as the study results suggests that this approach is useful when aiming to elucidate how students use situational factors and assessment types to integrate information that mediates their judgment to decide if academic dishonesty is a viable path to academic success. Indeed, as revealed in the present study, cognitive specification of an integration rule can help teachers understand how students cope with different types of assessments, which in turn allows them to establish if contextual educative environments can elicit academic dishonesty behaviour. A wide set of research possibilities can be introduced to explore academic dishonesty by considering cognitive specification of other factors related to desire to cheat like in the current study.

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Appendix

Imagine that, this school year, you had to take a statistic class taught by a lecturer who follows the correct agenda and objectives of the academic programme. This particular instructor always requires students to structure their learning activities independently, as well as master all selected readings. He will only provide guidance. Furthermore, the course evaluation will be based solely on a closed test (multiple choice, or true/false questions), which must be completed in under 90 minutes. The test is given in paper format in the classroom and is supervised by the lecturer.

How much are you willing to cheat to pass the test?

Not at all 0---0---0---0---0---0---0---0---0---0---0 A lot