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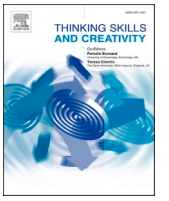

Disposition toward critical thinking and creative confidence beliefs in higher education students: The mediating role of openness to diversity and challenge

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ABSTRACT

Creative thinking and critical thinking are complementary cognitive processes that are important for dealing with complex challenges. The primary aim of this study was to examine the mediating role of openness to diversity and challenge in the relationship between disposition toward critical thinking and creative confidence beliefs in higher education students. Participants were 1,627 students from two universities in Spain (Mondragon Unibertsitatea and Florida Universitària), ranging in age from 17 to 44 years ($M_{age} = 20.35$, $SD = 2.62$; 53.05% female). Results showed not only a direct, positive relationship between critical thinking disposition and students' creative confidence beliefs but also that this relationship was mediated by openness to diversity and challenge. Thus, those students more disposed toward critical thinking are also more open to diversity and challenge and have a stronger creative self-concept. These results highlight the importance of enhancing students' disposition to use critical thinking so as to strengthen their creative self-concept. Higher education institutions also need to develop teaching strategies and contexts that promote students' openness to diversity and challenge as a step towards their becoming active and responsible citizens.

1. Introduction

Creativity is now recognized as being crucial to our ability to deal with contemporary social challenges (Glăveanu, 2020), and hence it has become a core goal across all levels of education (Snyder, Hammond, Grohman & Katz-Buonincontro, 2019). In this context, students' confidence in their own creative abilities has become a topic of growing interest among researchers (Redifer, Bae & Zhao, 2021), with studies showing that creative self-beliefs play a key role in the creative process (Anderson & Haney, 2020). More specifically, people with greater confidence in their ability to be creative are more likely to engage in creative tasks and to persevere when problems arise (Beghetto & Karwowski, 2017). According to Karwowski, Lebuda and Beghetto (2019), creative self-beliefs encompass both creative self-efficacy and creative self-concept. The former refers to a person's confidence in their ability to produce creative outcomes and to perform to a certain level in a specific context (Tierney & Farmer, 2002). As for creative self-concept, this reflects a more general belief about one's ability to be creative (Beghetto & Karwowski, 2017). Consistent with the view that

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creative self-concept is a crucial factor underpinning creative behavior and creative outcomes (Beghetto & Karwowski, 2017; Karwowski et al., 2019; Lebuda, Jankowska & Karwowski, 2020), some recent studies (Alvarez-Huerta, Muela & Larrea, 2021) have highlighted the importance of promoting creative self-beliefs in higher education, due to the close association with enhanced professional competences and healthy personal development (Egan, Maguire, Christophers & Rooney, 2017).

Another cognitive process that is complementary to and interdependent with our ability to think creatively is critical thinking (Silva & Iturra, 2021). The development of critical thinking skills is considered essential (Hyytinen, Toom & Shavelson, 2019) for building responsible citizens who are able to reflect on and evaluate the enormous amount of information that is now available (Behar-Horenstein & Niu, 2011), and accordingly it has become a key goal of higher education (Liyanage, Walker & Shokouhi, 2021). It has been suggested that critical thinking may be necessary for creative thinking to occur, as it ensures that ideas are applicable and relevant (Baum, Cennamo & Newbill, 2009; Qiang, Han, Guo, Bai & Karwowski, 2020; Wechsler et al., 2018), with some studies reporting associations between these variables and openness to diversity and challenge (Cayirdag, 2017; Longerbeam, 2010). However, it is unclear whether openness to diversity and challenge may play a mediating role in the relationship between critical thinking and creative self-concept. The primary aim of the present study was to examine these associations in higher education students.

2. Disposition toward critical thinking

The consensus definition of critical thinking is that it includes both a skill dimension and a dispositional dimension (Facione, Carol, Facione & Gainen, 1995; Sosu, 2013). The skill dimension of critical thinking implies the ability to understand problems and develop reasoned solutions to them (Sosu, 2013) through, for example, analysis, interpretation, and the drawing of conclusions (Chan, 2019). The dispositional dimension refers to a willingness to apply these skills when there is a problem to be solved or a decision to be made (Facione et al., 1995, 2000). Importantly, critical thinking skills are unlikely to be employed in practice without a strong disposition toward doing so (Chen, Liu, Zhou & Tang, 2020). According to Sosu (2013), the disposition toward critical thinking has two dimensions: critical openness and reflective skepticism. Critical openness reflects a tendency to be open to new ideas, to evaluate them critically, and to be prepared to modify one's views in light of the evidence. Reflective skepticism refers to a willingness to learn from past experience and to question the evidence.

Interest in the dispositional dimension of critical thinking, as opposed to the skill dimension, is a relatively recent phenomenon. Nevertheless, there is now evidence linking the disposition towards critical thinking to the use of higher-order thinking skills when solving problems (Darby & Rashid, 2017). It has also been associated with greater research competence among health care professionals (Chen et al., 2020), as well as with scientific creativity among high school students (Qiang et al., 2020).

3. Creative self-concept and the disposition toward critical thinking

It is widely recognized that creative thinking and critical thinking are complementary abilities (Facione, 1990; Halpern, 2003; Paul & Elder, 2006). Creative thinking involves both a divergent phase in which different ideas are generated and a convergent phase which involves synthesis and the evaluation of ideas (Qiang et al., 2020), modulated by distinct processes such as flexibility or persistence (Zhang, Sjoerds & Hommel, 2020) and potentially leading critical thinking to play differentiated roles in each of the phases. In fact, it is considered difficult for there to be creative thinking in the absence of critical judgment or thinking (Silva & Iturra, 2021). A number of recent studies have examined this relationship in the educational context. Tsai (2019) found a positive and strong relationship between critical thinking and creative thinking in Chinese university students. Eggers, Lovelace and Kraft (2017) found that critical thinking positively influenced the creativity of business students. In a study involving students attending university preparatory classes, Akpur (2020) observed a positive correlation between critical thinking, reflective thinking, and creative thinking, and also that these variables were all positive predictors of academic achievement. For their part, Liu et al. (2021) found that an integrated course of critical and creative thinking, based on social cognitive theory, increased creative self-efficacy and creative thinking disposition among nursing students. It should be noted, however, that the relationship between creative self-concept and the disposition toward critical thinking has not been sufficiently studied. It has been suggested that critical thinking may be a necessary precondition for creative thinking, as it ensures that ideas are applicable and relevant, by synthesizing, analyzing, and evaluating different ideas (Baum et al., 2009; Wechsler et al., 2018). Furthermore, in one recent study, Qiang et al. (2020) found that high school students' critical thinking disposition was positively related to their creative self-concept and scientific creativity, that is to say, their ability to generate new products or ideas of scientific value.

4. Openness to diversity and challenge

Openness to diversity and challenge is considered a goal of contemporary education that can help to prepare students for active citizenship (Alt, 2017; Ryder, Reason, Mitchell, Gillon & Hemer, 2016). It is defined as a willingness to challenge one's own beliefs and values, and to learn from diversity (Bowman, 2014; Whitt, Pierson, Nesheim, Marth & Pascarella, 2007). In the higher education context, openness to diversity and challenge promotes student engagement in meaningful educational experiences and quality peer interactions (Bowman, 2014; Pascarella, Edison, Nora, Serra Hagedorn & Terenzini, 1996; Whitt, Edison, Pascarella, Terenzini & Nora, 2001). In this regard, constructivist learning environments (Alt, 2017), participation in cultural awareness workshops, and frequent interaction with people with different social identities (Shim & Perez, 2018) have all been linked to increased openness to diversity and challenge among students.

5. Creative self-concept, openness to diversity and challenge, and critical thinking

Creative thinking and critical thinking are positively interrelated (Akpur, 2020; Liu et al., 2021). In the educational context, research has shown that there is a significant correlation between critical thinking skills and creative thinking skills on cognitive learning results among undergraduate students (Siburian, Corebima, Ibrohim & Saptasari, 2019), and that they play complementary roles in problem solving (Wechsler et al., 2018). Disposition to critical thinking has been mainly investigated as a predictor of critical thinking (Sosu, 2013), but it has also been found that students' critical thinking disposition is positively related to their creative self-concept and scientific creativity, and that creative self-concept mediates the link between critical thinking disposition and scientific creativity (Qiang et al., 2020).

There is also evidence of a relationship between critical thinking and openness to diversity and challenge. The pioneering study by Pascarella, Palmer, Moye and Pierson (2001) found that college students who showed a greater capacity for critical thinking were more open to diversity, a finding that has been corroborated in subsequent research. Longerbeam (2010), for example, found that students' critical thinking and sense of civic engagement was positively related to their openness to diversity. Studies have similarly found a positive association between critical thinking disposition and showing openness to new experience among high school students (Sepahvand, Yailagh, Porbirgany & Behrozi, 2018).

According to Whitt et al. (2021), students who show openness to diversity and challenge accept and welcome challenges to their beliefs. Openness to diversity and challenge has been defined as a psychology proclivity theoretically related to the personality trait of openness to experience (Bowman, 2014), which reflects a preference for novelty and difference over the conventional (McCrae & Ingraham, 1987; McCrae & Sutin, 2009). The interest in new experiences and knowledge that is characteristic of people who score high on this personality trait leads them to explore previously unknown ideas (Sola, Hoekstra, Fiore & McCauley, 2017). It is also suggested that highly open-minded people have more complex and comprehensive interpretations of the world (Matz, 2021). Research shows that they also hold a strong creative self-concept (Jaussi, Randel & Dionne, 2007; Lebuda et al., 2020; Silvia, Nusbaum, Berg, Martin & O'Conner, 2009). It has also been found that diversity of social ties, associated with a higher openness to diversity and challenge (Bowman, 2014), has a direct positive relationship with creative self-efficacy and an indirect positive relationship with employee creativity via creative self-efficacy (Gong, Kim & Liu, 2020).

6. The present study

It is clear from the above review of the literature that creative thinking and critical thinking have come to be regarded as fundamental cognitive processes in what is now an age of information overload (Roetzel, 2019). Accordingly, enhancing people's ability to generate and discriminate between different ideas, in other words, their capacity for creative and critical thinking, respectively (Combs, Cennamo & Leary Newbill, 2009; Puente-Diaz & Cavazos-Arroyo, 2020), has for many authors become a key educational goal (Badger, 2019; Bravo, Galiana, Rodrigo, Navarro-Pérez & Oliver, 2020; Miller & Dumford, 2016; Wechsler et al., 2018). If higher education institutions are to achieve this goal, they need access to reliable data and information on which to base the design and implementation of teaching strategies that can foster students' personal and professional development (Bezanilla, Fernández-Nogueira, Poblete & Galindo-Domínguez, 2019). In this respect, it should be noted that although the relationship between creative thinking and critical thinking is not a new topic of interest (Halpern, 2003; Paul & Elder, 2006; Wechsler et al., 2018), it has yet to be studied in sufficient depth (Qiang et al., 2020). On the one hand, there is now considerable theoretical and empirical support for the idea that critical thinking disposition may play a relevant role in creative self-beliefs (Qiang et al., 2020). However, although some recent studies (Beghetto & Karwowski, 2017; Karwowski et al., 2019) have found that creative self-beliefs influence a person's engagement and creative development, little attention has been paid to the relationship between the disposition toward critical thinking and creative self-beliefs, that is, how confident people feel in their ability to think or act creatively (Karwowski et al., 2019).

A further to issue to consider is that creative thinking involves certain attitudes and dispositions that involve being flexible and motivated (Baum et al., 2009), therefore, openness to diversity and challenge, which is related to critical thinking disposition (Sepahvand et al., 2018) may be a key component of creative self-concept. It is important to note that although openness to diversity and challenge has been related to the personality trait openness to experience, it is considered a state rather than a trait variable, given its capacity to be influenced by situational factors, such as university experiences (Bowman, 2014). To the best of our knowledge, however, the role that openness to diversity and challenge may play in the relationship between critical thinking disposition and creative confidence beliefs has yet to be investigated.

A better understanding of the relationship between students' confidence in their ability to generate new ideas and their disposition toward exploring such ideas and evaluating them with a critical eye would help to design teaching strategies and settings that can foster both critical and creative thinking among students. Therefore, the primary aim of the present study was to examine whether openness to diversity and challenge plays a mediating role in the relationship between disposition toward critical thinking and creative confidence beliefs in higher education students. We expected to find that students who show a stronger disposition toward critical thinking are also more open to diversity and challenge, which in turn leads them to have a stronger creative self-concept. As far as we are aware, this is one of the first studies of this kind to be conducted in the higher education context.

7. Method

7.1. Participants

Participants in this study were 1627 students from two universities in Spain (Mondragon Unibertsitatea and Florida Universitària), ranging in age from 17 to 44 years (M_{age} = 20.35, SD = 2.62; 53.05% female). They were enrolled in undergraduate (94.59%) and Master's (5.41%) programs in either a technical field or the social sciences.

7.2. Procedure

We began by recruiting a convenience sample from among students enrolled in the two aforementioned universities during the 2019–2020 and 2020–21 academic years. Data were then collected using the three instruments described in the next section, each of which was hosted online. Potential participants were first informed about the nature of the study, and how to access the questionnaires. It was made clear from the outset that participation was entirely voluntary and that all the information collected would remain confidential, in accordance with current data protection legislation in our country. All students who agreed to participate signed informed consent (electronically) prior to any data collection.

7.3. Instruments

Creative self-concept. This was measured using the Creative Self-Efficacy instrument (Tierney & Farmer, 2002), comprising three items (e.g., "I have confidence in my ability to solve problems creatively"), each rated on a 7-point Likert-type scale (1 = Totally disagree; 7 = Totally agree). The instrument, which takes around two minutes to complete, has been widely used in the educational field and shows good psychometric properties (Puente-Díaz, 2016). Internal consistency of scores in the present sample was 0.76 (Cronbach's alpha).

Openness to diversity and challenge. This was assessed using three items from the Openness to Diversity and Challenge scale (Bowman, 2014; Pascarella et al., 1996). Around two minutes is required to answer these items ("I enjoy having discussions with people whose ideas and values are different from my own"; "I enjoy taking courses that challenge my beliefs and values"; "The courses I enjoy most are those that make me think about things from a different perspective"), each of which is rated on a 5-point Likert-type scale (1 = Totally disagree; 5 = Totally agree). The Openness to Diversity and Challenge scale has been widely used in the university context (Alt, 2017; Bowman, 2014; Shim & Perez, 2018). Internal consistency of item scores in the present sample was acceptable (α = 0.71).

Disposition towards critical thinking. This was evaluated using the Critical Thinking Disposition Scale (CTDS; Spanish adaptation by Bravo et al., 2020; original instrument by Sosu, 2013). The CTDS comprises 11 items that measure critical openness (e.g., I usually try to think about the bigger picture during a discussion) and reflective skepticism (e.g., I often re-evaluate my experiences so that I can learn from them), two components of the disposition towards critical thinking. Each item is rated on a 5-point Likert-type scale (1 = Totally disagree; 5 = Totally agree) and around four minutes are needed to complete the scale. Internal consistency of scale scores (Cronbach's alpha) in the present sample was 0.75 and 0.70 for the dimensions of critical openness and reflective skepticism, respectively.

7.4. Data analysis

We began by conducting a descriptive analysis for all variables of interest, as well as a bivariate correlation analysis involving the

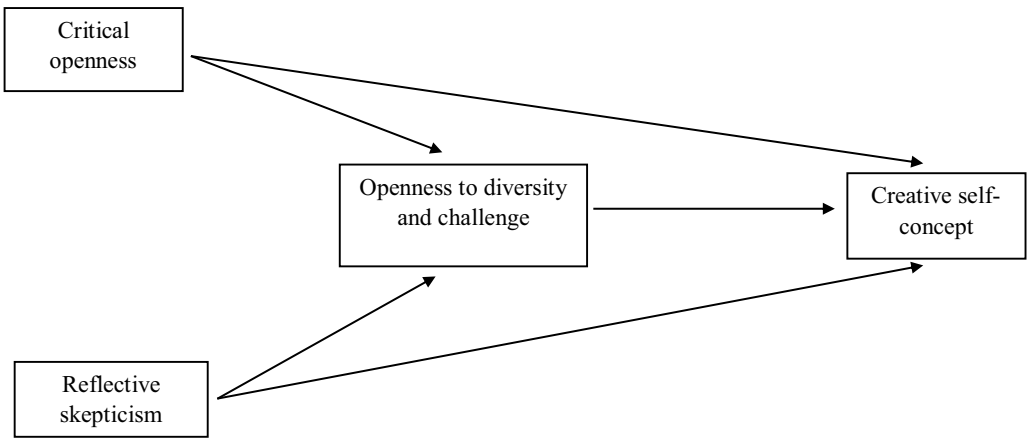

Fig. 1. Conceptual framework of the mediation model.

calculation of Pearson coefficients. Next, and in order to rule out the possibility that openness to diversity and challenge was a confounding variable in the relationship between creative self-concept and both critical openness and reflective skepticism, we performed a partial correlation analysis, controlling for openness to diversity and challenge. Finally, we tested a mediation model to examine whether openness to diversity and challenge was a mediator of the relationship between creative self-concept and both critical openness and reflective skepticism. The model was tested using maximum likelihood estimation and 10,000 bootstrapping samples at 95%. All data analyses were performed using Mplus 7.4 (Muthén & Muthén, Muthén & Asparouhov, 2016). The proportion of the total effect that is mediated was calculated using the formula proposed by MacKinnon, Warsi and Dwyer (1995). The conceptual framework of the mediation model is shown in Fig. 1.

8. Results

8.1. Descriptive statistics and correlations

To examine the relationship between the various study variables, we performed a linear correlation analysis. It can be seen in Table 1 that creative self-concept was positively related to openness to diversity and challenge, critical openness, and reflective skepticism. Similarly, openness to diversity and challenge was positively associated with both critical openness and reflective skepticism. A positive and statistically significant relationship was also observed between critical openness and reflective skepticism.

Table 1 also shows the partial correlations obtained when controlling for openness to diversity and challenge, the hypothesized mediating variable in the relationship between both critical openness and reflective skepticism and creative self-concept. As expected, controlling for this variable reduced the magnitude of the zero-order Pearson correlations, but it did not change the statistical significance of the Pearson correlations between the two dimensions of critical thinking disposition and creative self-concept. We therefore conclude that openness to diversity and challenge is not a confounding variable in this relationship.

8.2. Mediation analysis

The fit of the measurement component of the model was tested through confirmatory factor analysis (CFA). The parameters were estimated using the robust maximum likelihood method. The proposed model showed acceptable fit indices, $\chi_2[113] = 611.600$; $p < .001$.; CFI = 0.929; TLI = 0.915; RMSEA [90% CI] = 0.052 [.048, 0.057]; SRMR = 0.041. Measurement invariance by gender was also examined.

Table 2 shows the direct effects of the two dimensions of critical thinking disposition (critical openness and reflective skepticism) on creative self-concept, as well as its indirect effects via openness to diversity and challenge.

It can be seen in Table 2 that critical openness had a statistically significant indirect effect via openness to diversity and challenge on creative self-concept, $b = 0.03$, 95% CI [0.163, 0.279]. However, a statistically significant indirect effect of reflective skepticism was not observed. In terms of the magnitude of the mediation effect, 12% of the effect of critical openness on creative self-concept occurred indirectly through openness to diversity and challenge. These results indicate that critical openness has a positive effect on openness to diversity and challenge, such that students who score higher on critical openness are also more open to diversity and challenge, which in turn results in higher levels of creative self-concept.

9. Discussion

The aim of this study was to examine the mediating role of openness to diversity and challenge in the relationship between disposition toward critical thinking and creative confidence beliefs in higher education students. As expected, we observed a direct, positive relationship between students' critical thinking disposition and their creative self-concept. Thus, those students with a greater disposition to critical thinking also tended to be more open to new ideas and to perceive themselves to have a stronger creative self-concept. This finding is consistent with previous studies showing a positive relationship between creative thinking and critical thinking (Halpern, 2003; Paul & Elder, 2006; Wechsler et al., 2018), and it lends further support to the idea that a disposition toward critical thinking may be a necessary component of creative thinking (Qiang et al., 2020).

Importantly, we also found that the relationship between students' disposition toward critical thinking and their creative confidence beliefs was mediated by openness to diversity and challenge. In other words, those students who were more disposed toward

Table 1
Descriptive statistics, zero-order Pearson correlations, and partial correlations controlling for openness to diversity and challenge.

			Zero-order Pearson correlations				Partial correlations		
Variable	*M*	*SD*	ODC	CS	CO	RS	CS	CO	RS
ODC	11.94	2.06	—						
CS	15.59	2.60	.29***	—					
CO	27.70	3.79	.57***	.45***	—		.36***		
RS	15.36	2.49	.43***	.34***	.64***	—	.24***	.53***	—

ODC: Openness to diversity and challenge; CS: Creative self-concept; CO: Critical openness; RS: Reflective skepticism.
*$p < .05$., **$p < .01$., ***$p < .001$.

Table 2
Direct effects of the disposition toward critical thinking on creative self-concept, and its indirect effects via openness to diversity and challenge.

	Estimate	Std. Error	*p*	95% Confidence Interval Lower	Upper
Direct effects					
CO → CS	0.221	0.029	0.0001	0.163	0.279
RS → CS	0.105	0.036	.0004	0.034	0.176
Indirect effects					
CO → ODC → CS	0.030	0.013	.0022	0.004	0.055
RS → ODC → CS	0.008	0.005	.075	−0.001	0.017
Total effects					
CO → CS	0.251	0.027	0.0001	0.197	0.304
RS → CS	0.113	0.036	.002	0.043	0.184

CS: Creative self-concept; CO: Critical openness; RS: Reflective skepticism; ODC: Openness to diversity and challenge.

new ideas and more willing to learn from past experiences and to question the evidence were also more open to diversity and challenge leading them, in turn, to be more confident about their creative abilities. This pattern of relationships has important implications for higher education, insofar as it highlights the need to promote students' openness to diversity and challenge as a step towards their becoming active and responsible citizens (Shim & Perez, 2018). Openness to diversity and challenge is not only a personal characteristic that students need to develop if they are to prosper in an increasingly diverse society (Whitt et al., 2001), but is also an attribute that can encourage them to engage in meaningful learning experiences (Bowman, 2014). We would argue, therefore, that educational institutions must create opportunities for students to encounter different views and perspectives on life and the world in which we live. This could be achieved, for example, through contact with teachers who are open to working from multiple perspectives (Ryder et al., 2016), through cooperative learning environments (Alt, 2017), and through teaching strategies that promote intercultural understanding among students (Shim & Perez, 2018).

In our view, and as other authors have pointed out (Özdemir, Özdemir & Boersma, 2021), understanding why some young people are more open than others to diversity and challenge is crucial for identifying ways of encouraging social interaction and building a more inclusive society. In fact, one could argue that this is particularly important in the case of young people, insofar as they are still at the stage of developing their competences and life skills (Mayhew et al., 2016). Despite, however, a growing body of research (Alt, 2017; Ryder et al., 2016; Shim & Perez, 2018) identifying certain institutional practices and characteristics that can help to promote students' openness to diversity and challenge, less is known about the intrapersonal factors that may contribute to the same goal, especially those related to students' surface characteristics of personality. Thus, although various studies have suggested a link between critical thinking and the disposition to seek out new and diverse experiences (Longerbeam, 2010; Sepahvand et al., 2018), the association found in the present study between students' critical thinking disposition and their openness to diversity and challenge offers a new perspective from which to promote the development of these skills in higher education. As some authors have recently argued (Wan, 2021), in order for students to develop disposition toward critical thinking and show greater openness to diversity and challenge, more effort should be made to improve learning environments by motivating students to make connections between their learning and the world around them, and by illustrating that people's ideas, positions and knowledge are conditional.

Given that openness to different ideas and reflection may be a prerequisite for engaging in creative thinking (Baum et al., 2009) and in light of previous studies on the relationship between openness to diversity and challenge and creative self-beliefs in students (Jaussi et al., 2007; Lebuda et al., 2020; Silvia et al., 2009), we also sought to explore the association between students' critical openness and reflective skepticism, the two dimensions of critical thinking disposition (Sosu, 2013) and their openness to diversity and challenge and creative self-concept. According to Sosu (2013), critical openness reflects a tendency to be actively open to new ideas and overlaps theoretically with the open mindedness construct. Our results appear to support the proposed theoretical association between the critical openness dimension of critical thinking disposition and openness to diversity and challenge. Thus, although further studies are required, it appears that students who are open to new ideas and to critically evaluate these ideas are also more willing to challenge one's own beliefs and values, and to learn from diversity. Contrary to our expectations, no relationship has been found between reflective skepticism, defined as a willingness to learn from past experience and to question the evidence, and openness to diversity and challenge. This result suggests that reflective analysis of ideas through personal experience, as represented by the reflective skepticism variable, could be part of a different and complementary relationship with the creative process described by openness to diversity and challenge and which may relate to divergent thinking, a phase characterized by greater flexibility (Zhang et al., 2020). In sum, although further studies are required, one might speculate that the mechanism that underlies the proposed relationship between critical thinking disposition and creative self-concept might be explained by the inclusion of the critical openness variable.

This study has a number of limitations. First, although our results support the proposed mediation model, in which critical thinking disposition has an indirect effect on creative self-concept via openness to diversity and challenge, they should nonetheless be interpreted with caution, given the cross-sectional design. Although there are theoretical arguments to assume the proposed relationships, causality cannot be established among the variables and there is a possibility that reciprocal links exist. A second limitation is that participants came from just two Spanish universities, and it is therefore unclear to what extent the findings may be generalizable. Although we sought to address this issue by recruiting a considerable number of students from different disciplines, further studies involving students from other knowledge areas, universities, and countries are required. Therefore, the use of longitudinal designs

would be useful not only to corroborate our findings but also to explore how students' creative confidence beliefs, openness to diversity and challenge, and disposition to critical thinking may evolve as they progress through their studies. An expert panel could be involved for future studies in order to assess the validity of the instruments with fewer than 4 items. Finally, although we consider that our study adds to knowledge about the relationship between creative self-concept and critical thinking disposition in higher education, the use in future studies of more recent measurement instruments such as the Short Scale of Creative Self (Karwowski & Lebuda, 2018) would provide more precise information on variables that are relevant to this area of research, such as creative self-concept or creative identity.

10. Conclusion

The results of this study confirm that openness to diversity and challenge does, as hypothesized, play a mediating role in the relationship between disposition toward critical thinking and creative confidence beliefs in higher education students. Those students more disposed toward critical thinking are also more open to diversity and challenge leading them, in turn, to perceive themselves to have a stronger creative self-concept. This finding opens up new and important lines of research, and it has practical implications for the higher education context. In particular, it highlights the importance of fostering students' critical thinking disposition, firstly so that they are willing to use critical thinking when there is a problem to be solved or a decision to be made, and secondly so as to cultivate both their capacity to appreciate and live with diversity and their confidence in their creative abilities.

CRediT authorship contribution statement

Paula Álvarez-Huerta: Conceptualization, Writing – original draft, Formal analysis. **Alexander Muela:** Formal analysis, Data curation, Writing – original draft. **Iñaki Larrea:** Data curation, Writing – original draft, Formal analysis.

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References

Akpur, U. (2020). Critical, reflective, creative thinking and their reflections on academic achievement. *Thinking Skills and Creativity, 37*. https://doi.org/10.1016/j.tsc.2020.100683

Alt, D. (2017). Constructivist learning and openness to diversity and challenge in higher education environments. *Learning Environments Research, 20*(1), 99–119. https://doi.org/10.1007/s10984-016-9223-8

Alvarez-Huerta, P., Muela, A., & Larrea, I. (2021). Student engagement and creative confidence beliefs in higher education. *Thinking Skills and Creativity, 40*(100821). https://doi.org/10.1016/j.tsc.2021.100821

Anderson, R. C., & Haney, M. (2020). Reflection in the creative process of early adolescents: The mediating roles of creative metacognition, self-efficacy and self-concept. *Psychology of Aesthetics, Creativity, and the Arts, 2*. https://doi.org/10.1037/aca0000324

Badger, J. (2019). A case study of Chinese students' and IEP faculty perceptions of a creativity and critical thinking course. *Higher Education Studies, 9*(3), 34. https://doi.org/10.5539/hes.v9n3p34

Baum, L. C., Cennamo, K. S., & Newbill, P. L. (2009). Developing Critical and Creative Thinkers: Toward a Conceptual Model of Creative and Critical Thinking Processes. *Educational Technology, 49*(5), 3–14.

Beghetto, R.A., .& Karwowski, M. (2017). Towards untangling creative self-beliefs. In M. Karwowski & J. C. Kaufman (Eds.), The creative self: Effect of beliefs, self-efficacy, mindset, and identity (pp. 1–394). Academic Press Inc. 10.1016/C2015-0-07011-3.

Behar-Horenstein, L. S., & Niu, L. (2011). Teaching critical thinking skills in higher education: A review of the literature. *Journal of College Teaching & Learning-February, 8*(2). https://doi.org/10.19030/tlc.v8i2.3554

Bezanilla, M. J., Fernández-Nogueira, D., Poblete, M., & Galindo-Domínguez, H. (2019). Methodologies for teaching-learning critical thinking in higher education: The teacher's view. *Thinking Skills and Creativity, 33*, Article 100584. https://doi.org/10.1016/j.tsc.2019.100584

Bowman, N. A. (2014). Conceptualizing openness to diversity and challenge: Its relation to college experiences, achievement, and retention. *Innovative Higher Education, 39*(4), 277–291. https://doi.org/10.1007/s10755-014-9281-8

Bravo, M. J., Galiana, L., Rodrigo, M. F., Navarro-Pérez, J. J., & Oliver, A. (2020). An adaptation of the critical thinking disposition scale in Spanish youth. *Thinking Skills and Creativity, 38*. https://doi.org/10.1016/j.tsc.2020.100748

Cayirdag, N. (2017). Creativity fostering teaching: Impact of creative self-efficacy and teacher efficacy. *Educational Sciences: Theory & Practice, 17*(6), 1959–1975. https://doi.org/10.12738/estp.2017.6.0437

Chan, C. (2019). Using digital storytelling to facilitate critical thinking disposition in youth civic engagement: A randomized control trial. *Children and Youth Services Review, 107*(July), Article 104522. https://doi.org/10.1016/j.childyouth.2019.104522

Chen, Q., Liu, D., Zhou, C., & Tang, S. (2020). Relationship between critical thinking disposition and research competence among clinical nurses: A cross-sectional study. *Journal of Clinical Nursing, 29*(7–8), 1332–1340. https://doi.org/10.1111/jocn.15201

Combs, L. B., Cennamo, K. S., & Leary Newbill, P. (2009). Developing critical and creative thinkers: Toward a conceptual model of creative and critical thinking processes. *In Technology, 49*(5), 3–14. https://www.jstor.org/stable/44429711?seq=1&cid=pdf.

Darby, N. M., & Rashid, A. M. (2017). Critical thinking disposition: The effects of infusion approach in engineering drawing. *Journal of Education and Learning, 6*(3), 305. https://doi.org/10.5539/jel.v6n3p305

Egan, A., Maguire, R., Christophers, L., & Rooney, B. (2017). Developing creativity in higher education for 21st century learners: A protocol for a scoping review. *International Journal of educational research, 82*, 21–27. https://doi.org/10.1016/j.ijer.2016.12.004

Eggers, F., Lovelace, K. J., & Kraft, F. (2017). Fostering creativity through critical thinking: The case of business start-up simulations. *Creativity and Innovation Management, 26*(3), 266–276. https://doi.org/10.1111/caim.12225

Facione, P.A. (.1990). Critical thinking: A statement of expert consensus for purposes of educational assessment and instruction. Research findings and recommendations. In: ERIC document (No. ED315423).

Facione, P. A., Carol, A. S., Facione, N. C., & Gainen, J. (1995). The disposition toward critical thinking. *Journal of General Education, 44*(1), 1–25.

Gläveanu, V. (2020). Creativity and global citizenship education. In A. Akkari, & K. Maleq (Eds.), *Global citizenship education*. Springer International Publishing. https://doi.org/10.1007/978-3-030-44617-8.

Gong, Y., Kim, T. Y., & Liu, Z. (2020). Diversity of social ties and creativity: Creative self-efficacy as mediator and tie strength as moderator. *Human Relations, 73*(12), 1664–1688. https://doi.org/10.1177/0018726719866001

Halpern, D. F. (2003). Thinking critically about creative thinking. In M. A. Runco (Ed.), *Critical creative processes* (pp. 189–207). Hampton Press.

Hyytinen, H., Toom, A., & Shavelson, R. J. (2019). Enhancing scientific thinking through the development of critical thinking in higher education. In M. Murtonen, & K. Balloo (Eds.), *Redefining scientific thinking for higher education: Higher order thinking, evidence-based reasoning and research skills* (pp. 59–78). Palgrave Macmillan.

Jaussi, K. S., Randel, A. E., & Dionne, S. D. (2007). I am, I think I can, and I do: The role of personal identity, self-efficacy, and cross-application of experiences in creativity at work. *Creativity Research Journal, 19*(2–3), 247–258. https://doi.org/10.1080/10400410701397339

Karwowski, M., & Lebuda, I. (2018). Measuring creative self-efficacy and creative personal identity. *The International Journal of Creativity & Problem Solving, 28*(1), 45–57.

Karwowski, M., Lebuda, I., & Beghetto, R. A. (2019). Creative self-beliefs. In J. C. Kaufman, & R. J. Sternberg (Eds.), *The cambridge handbook of creativity* (pp. 396–418). Cambridge University Press.

Lebuda, I., Jankowska, D. M., & Karwowski, M. (2020). Parents' creative self-concept and creative activity as predictors of family lifestyle. *International Journal of Environmental Research and Public Health, 17*(24), 1–18. https://doi.org/10.3390/ijerph17249558

Liu, T., Yu, X., Liu, M., Wang, M., Zhu, X., & Yang, X. (2021). A mixed method evaluation of an integrated course in improving critical thinking and creative self-efficacy among nursing students. *Nurse Education Today, 106*, Article 105067. https://doi.org/10.1016/j.nedt.2021.105067

Liyanage, I., Walker, T., & Shokouhi, H. (2021). Are we thinking critically about critical thinking? Uncovering uncertainties in internationalised higher education. *Thinking Skills and Creativity, 39*. https://doi.org/10.1016/j.tsc.2020.100762

Longerbeam, S. D. (2010). Developing openness to diversity in living-learning program participants. *Journal of Diversity in Higher Education, 3*(4), 201–217. https://doi.org/10.1037/a0021277

MacKinnon, D. P., Warsi, G., & Dwyer, J. H. (1995). A simulation study of mediated effect measures. *Multivariate Behavioral Research, 30*(1), 41–62.

Matz, S. C. (2021). Personal echo chambers: Openness-to-experience is linked to higher levels of psychological interest diversity in large-scale behavioral data. *Journal of Personality and Social Psychology*. https://doi.org/10.1037/pspp0000324.supp

Mayhew, M. J., Rockenbach, A. N., Bowman, N. A., Seifert, T. A., Wolniak, G. C., Pascarella, E. T., et al. (2016). How college affects students. *Volume 3, 21st century evidence that higher education works*. Jossey-Bass.

McCrae, R. R., & Ingraham, L. J. (1987). Creativity, divergent thinking, and openness to experience. *Journal of Personality and Social Psychology, 52*(6), 1258–1265. https://doi.org/10.1037/0022-3514.52.6.1258

McCrae, R. R., & Sutin, A. R. (2009). Openness to experience. *Handbook of individual differences in social behavior, 2000*, 257–273.

Miller, A. L., & Dumford, A. D. (2016). Creative cognitive processes in higher education. *Journal of Creative Behavior, 50*(4), 282–293. https://doi.org/10.1002/jocb.77

Muthén, L. K., Muthén, B., & Asparouhov, T. (2016). *Regression and mediation analysis using mplus*. Muthén & Muthén.

Özdemir, S. B., Özdemir, M., & Boersma, K. (2021). How does adolescents' openness to diversity change over time? The role of majority-minority friendship, friends' views, and classroom social context. *Journal of Youth and Adolescence, 50*(1), 75–88. https://doi.org/10.1007/s10964-020-01329-4

Pascarella, E. T., Edison, M., Nora, A., Serra Hagedorn, L., & Terenzini, P. T. (1996). Influences on students' openness to diversity and challenge in the first year of college. *Journal of Higher Education, 67*(2), 174–195. https://doi.org/10.2307/2649321

Pascarella, E. T., Palmer, B., Moye, M., & Pierson, C. T. (2001). Do diversity experiences influence the development of critical thinking? *Journal of College Student Development, 42*(3), 257–271.

Paul, R., & Elder, L. (2006). Critical thinking competency standards. *Foundation for critical thinking*.

Puente-Díaz, R. (2016). Creative self-efficacy: An exploration of its antecedents, consequences, and applied implications. *The Journal of Psychology, 150*(2), 175–195. https://doi.org/10.1080/00223980.2015.1051498

Puente-Diaz, R., & Cavazos-Arroyo, J. (2020). Creative metacognitive feelings as a source of information for creative self-efficacy, creativity potential, intrapersonal idea selection, and task enjoyment. *Journal of Creative Behavior, 54*(3), 499–507. https://doi.org/10.1002/jocb.384

Qiang, R., Han, Q., Guo, Y., Bai, J., & Karwowski, M. (2020). Critical thinking disposition and scientific creativity: The mediating role of creative self-efficacy. *Journal of Creative Behavior, 54*(1), 90–99. https://doi.org/10.1002/jocb.347

Redifer, J. L., Bae, C. L., & Zhao, Q. (2021). Self-efficacy and performance feedback: Impacts on cognitive load during creative thinking. *Learning and Instruction, 71* (June 2020), Article 101395. https://doi.org/10.1016/j.learninstruc.2020.101395

Roetzel, P. G. (2019). Information overload in the information age: A review of the literature from business administration, business psychology, and related disciplines with a bibliometric approach and framework development. *Business Research, 12*(2), 479–522. https://doi.org/10.1007/s40685-018-0069-z

Ryder, A. J., Reason, R. D., Mitchell, J. J., Gillon, K., & Hemer, K. M. (2016). Climate for learning and students' openness to diversity and challenge: A critical role for faculty. *Journal of Diversity in Higher Education, 9*(4), 339–352. https://doi.org/10.1037/a0039766

Sepahvand, E., Yailagh, M. S., Porbirgany, S. A., & Behrozi, N. (2018). Testing a model of causal relationships of family communication patterns, metacognition, and personality traits with critical thinking disposition, mediated by epistemic beliefs of female high school students in Ahvaz. *International Journal of Psychology, 12* (1), 50–80. https://doi.org/10.22055/PSY.2017.21157.1756

Shim, W., & Perez, R.J. (.2018). A multi-level examination of first-year students' openness to diversity and challenge. *The Journal of Higher Education*, 1–25. 10.1080/00221546.2018.1434277.

Siburian, J., Corebima, A. D., Ibrohim, & Saptasari, M. (2019). The correlation between critical and creative thinking skills on cognitive learning results. *Eurasian Journal of Educational Research, 2019*(81), 99–114. https://doi.org/10.14689/ejer.2019.81.6

Silva, C., & Iturra, C. (2021). A conceptual proposal and operational definitions of the cognitive processes of complex thinking. *Thinking Skills and Creativity, 39*, 1871. https://doi.org/10.1016/j.tsc.2021.100794

Silvia, P. J., Nusbaum, E. C., Berg, C., Martin, C., & O'Conner, A. (2009). Openness to experience, plasticity, and creativity: Exploring lower-order, high-order, and interactive effects. *Journal of Research in Personality, 43*(6), 1087–1090. https://doi.org/10.1016/j.jrp.2009.04.015

Snyder, H. T., Hammond, J. A., Grohman, M. G., & Katz-Buonincontro, J. (2019). Creativity measurement in undergraduate students from 1984 to 2013: A systematic review. *Psychology of Aesthetics, Creativity, and the Arts, 13*(2), 133–143. https://doi.org/10.1037/aca0000228.supp

Sola, E., Hoekstra, R., Fiore, S., & McCauley, P. (2017). An investigation of the state of creativity and critical thinking in engineering undergraduates. *Creative Education, 08*(09), 1495–1522. https://doi.org/10.4236/ce.2017.89105

Sosu, E. M. (2013). The development and psychometric validation of a critical thinking disposition scale. *Thinking Skills and Creativity, 9*, 107–119. https://doi.org/10.1016/j.tsc.2012.09.002

Tierney, P., & Farmer, S. M. (2002). Self-efficacy: Its potential antecedents and relationship to creative performance. *Academy of Management Journal, 45*(6), 1137–1148. https://doi.org/10.2307/3069429

Tsai, K. C. (2019). Investigating the Empirical Links between Creative and Critical Thinking. *Psychology, Society & Education, 11*(3), 267–280. https://doi.org/10.25115/psye.v10i1.1064

Wan, Z. H. (2021). What predicts students' critical thinking disposition? A comparison of the roles of classroom and family environments. *Learning Environments Research*. https://doi.org/10.1007/s10984-021-09381-y

Wechsler, S. M., Saiz, C., Rivas, S. F., Vendramini, C. M. M., Almeida, L. S., Mundim, M. C., et al. (2018). Creative and critical thinking: Independent or overlapping components? *Thinking Skills and Creativity, 27*, 114–122. https://doi.org/10.1016/j.tsc.2017.12.003

Whitt, E. J., Edison, M. I., Pascarella, E. T., Terenzini, P. T., & Nora, A. (2001). Influences on students openness to diversity and challenge in the second and third years of college. *The Journal of Higher Education, 72*(2), 172–204.

Whitt, E. J., Pierson, C. T., Nesheim, B. S. E., Marth, B. P., & Pascarella, E. T. (2007). Differences between women and men in objectively measured outcomes, and the factors that influence those outcomes, in the first three years of college. *Journal of College Student Development, 44*(5), 587–610. https://doi.org/10.1353/csd.2003.0060

Zhang, W., Sjoerds, Z., & Hommel, B. (2020). Metacontrol of human creativity: The neurocognitive mechanisms of convergent and divergent thinking. *NeuroImage, 210*, Article 116572. https://doi.org/10.1016/j.neuroimage.2020.116572