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The Impact of Educational Diversity and Horizontal Mismatch on Technical Innovation

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THE IMPACT OF EDUCATIONAL DIVERSITY AND HORIZONTAL MISMATCH ON TECHNICAL INNOVATION AT THE ORGANISATION LEVEL

Innovation by technical employees is an important means of creating sustained competitive advantage for firms in the high-technology sector (A. Joshi & Roh, 2009; Thornhill, 2006). The relationship between employee and innovation at the organisation level has been partially described by human capital. From this literature, employee diversity has emerged as a key mechanism (Hitt, Biermant, Shimizu, & Kochhar, 2001; Subramaniam & Youndt, 2005), with Unger, Rauch, Frese, and Rosenbusch (2011) highlighting education and job role diversity in particular. However, Laursen, Mahnke, and Vejrup-Hansen (2004) and Carnabuci and Dioszegi (2015) emphasise that significant questions remain as to how these diversity characteristics interact across organisational levels to affect innovation.

In the labour economics literature mismatch between field of education and job role (horizontal mismatch) is increasingly recognised as an important predictor of employee satisfaction, productivity, and innovation (McGuinness & Sloane, 2011). Although traditional labour economics studies have focused on the impact of horizontal mismatch on the employee, a number of outcomes relevant to technical innovation at the organisation level have been identified in relation to this phenomena (Robst, 2007). For example, Østergaard, Timmermans, and Kristinsson (2011) explore the link between mismatch and employee innovation.

In this article we use horizontal mismatch as a new lens with which to decompose education/job role diversity effects on organisation innovation. We hypothesise causal relationships between horizontal mismatch at the technical employee and management team levels and innovation at the organisation level. Following prior studies, technical inventions
are used as a proxy for innovation (Ahuja & Katila, 2001; Hall & Ziedonis, 2001; Jaffe & Trajtenberg, 2002). Drawing on the mismatch literature we model a specific causal relationship in which alignment between job role at the technical employee and management team levels, as well as alignment between these levels impacts innovation at the organisation level (Note that we do not claim to prove causality, rather we test models that strongly infer causality). In keeping with both human capital literature (A. Joshi & Roh, 2009) and recent research (e.g., Østergaard el al. (2011)), our treatment of education/job role diversity and mismatch is based on organisation level aggregation. Hence our treatment is more specific to the organisational context than is typical of employee focused labour economics literature. Further, we utilise detailed register data on Danish firms and employees provided by the Danish statistics bureau (Statistics Denmark). This data provides in-depth information on both the firm level and individual level.

Consequently, this study has several implications for human capital and organisation innovation scholarship. First, most human capital research has focused on the overall impact of education and diversity on organisational performance, leaving questions regarding the relationships between these elements (Ployhart, Van Iddekinge, & MacKenzie, 2011). Specifically, there is robust evidence for education/job role diversity having a significant effect on innovation at the organisation level, however, the exact nature of the relationship remains unclear (Østergaard et al., 2011). Similarly, there is strong evidence for a relationship between education/job role mismatch and individual innovation (McGuinness & Sloane, 2011). Horizontal mismatch thus offers a new means of exploring the relationship between human capital and innovation at the organisation level. We examine the role of horizontal mismatch in moderating human capital diversity effects on innovation in high-technology sector firms (Thornhill, 2006). Second, we broaden the investigation of the interrelationships between diversity and mismatch at different levels within the organisation
to include technical employee and management team. This extends previous works that have primarily focused on top-management-team diversity (Cannella, Park, & Lee, 2008). Zarutskie (2010), Crook, Todd, and Combs (2011) suggest that both employee and management team human capital have specific effects on innovation. However, the role of diversity and mismatch in each group, as well as alignment between them, has not been extensively explored (A. Joshi & Roh, 2009). We explore the relationship between these human capital resources and how their interaction contributes to innovation at the organisation level (Ployhart et al., 2011). Finally, of the studies reviewed by Joshi and Roh (2009) only five dealt explicitly with education, and of these only one built on longitudinal data (six months) (Kearney & Gebert, 2009). This lack of longitudinal examination is particularly problematic in the dynamic context of the high-technology sector where changing technical demands pose challenges for human capital. We structure our data in a panel format, employing a zero inflated negative binomial model common when analysing count data. Our sample contains a balanced panel covering a 10-year window, presenting the unique opportunity to capture the effects of employee education and horizontal mismatch over time.

**MODEL AND CONTEXT**

Individual innovation is important to organisational success and building sustained competitive advantage in the high-technology sector (A. Joshi & Roh, 2009; Van de Ven, 1986). Technical employees are the primary source of innovation and fill roles spanning the range of product and knowledge creation activities (Thornhill, 2006). In this context Ahuja and Katila (2001) show technical inventions, measured via patent applications, to be an appropriate proxy for innovation. Although technical employees are the primary originators of innovation this is strongly moderated by the management team via e.g. role-modelling or stimulation (De Jong & Den Hartog, 2007; Scott & Bruce, 1994). At the technical employee
level there is a high degree of teamwork required in the knowledge creation process meaning that individual level characteristics are likely to aggregate to the organisational level (Jiang, Lepak, Hu, & Baer, 2012). Similarly, uniformity of technical management strategy means that individual managers are also likely able to be aggregated (Subramaniam & Youndt, 2005).

Figure 1a presents the organisational level model we test in this study. The model is developed for a high-technology sector context but is based more generally on human capital theory. As discussed in more detail below, changes in technical employee and management team human capital (educational diversity and horizontal mismatch) lead to changes in organisational performance (innovation measured via patent production). Further, there is an interaction effect between technical employee and management team human capital (educational diversity and horizontal mismatch), which also influences innovation at the organisation level. The dimensions of alignment between these characteristics are illustrated in Figure 1b for clarity.

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Insert Figure 1a about here
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HYPOTHESES

Technical Employee Educational Diversity and Horizontal Mismatch Impact Innovation at the Organisation Level

D’Aveni (1996) and more recently Hitt et al. (2001) emphasise employee education as a key component of human capital and subsequently innovation at the organisation level across the whole span of an employee’s career. In this context Kearny et al. (2009) and
Østergaard et al. (2011) identify diversity of education within the body of technical employees as one of the main correlates of innovation at the organisational level. Further, Faems and Subramanian (2013) and Post et al. (2009) describe educational diversity as a predictor of innovation at the employee level, particularly in roles where cognitive load is high e.g. in the high-technology sector. The importance of the link between innovation performance and educational diversity is further elaborated by van Dijk et al. (2012) who showed that diversity was more positively related to innovation performance than in-role performance.

Current models of educational diversity in the technical employee population are moderated by factors, including, social capital, leadership, motivation, and recognition of an employee’s skills and contributions in practice (A. Joshi & Roh, 2009; McMahon, 2010). However, these are little explored due to a general focus on cultural and gender diversity in the management literature (A. Joshi & Roh, 2009; Williams & O’Reilly III, 1998). Further, of those studies to include educational diversity in the recent review of Joshi and Roh (2009) only two reported longitudinal data (following individual teams for six months (Kearney et al., 2009; Kearney & Gebert, 2009)). As such, there is a need to examine the longitudinal interaction between educational diversity and innovation. Hypothesis 1a addresses prior limitations by targeting education diversity specifically with respect to longitudinal innovation at the organisation level in the context of the high-technology sector:

**Hypothesis 1a.** High technical employee educational diversity has a positive affect on innovation at the organisation level in the high-technology sector.

Decomposing the link between educational diversity and innovation performance Jiang et al. (2012) and Bassett-Jones (2005) highlight the importance of personal recognition, motivation, and job satisfaction. In parallel to the human capital literature these mechanisms have been described at a workforce level in research on horizontal mismatch. In this context,
horizontal mismatch is defined as a lack of alignment between an employee’s field of education and their specific occupation (Nordin, Persson, & Rooth, 2010). McGuinness and Sloane (2011) specifically connect greater alignment between job role and educational specialisation to improved motivation, greater job satisfaction, and subsequently, greater employee innovation. Reduced horizontal mismatch can thus be linked to improved innovation at the organisation level via employee level performance increases as in the human capital literature (Jiang et al., 2012; Nordin et al., 2010). However, no prior studies have directly examined the effect of horizontal mismatch at the organisational level, or with respect to technical employees specifically. Hypothesis 1b thus brings together horizontal mismatch and human capital literature to explicitly link mismatch to innovation at the organisation level in the high-technology sector:

**Hypothesis 1b.** Low technical employee horizontal mismatch has a positive effect on innovation at the organisation level.

Horizontal mismatch and educational diversity share mechanisms linking them to improved innovation performance. For example, McMahon (2010) and McGuinness and Sloane (2011) highlight increased motivation and job satisfaction stemming from both greater educational diversity and reduced horizontal mismatch. In both domains (human capital and horizontal mismatch) this improvement is moderated by factors such as, acceptance and recognition of employees’ skills and contribution to the organisation (Ho, 2015; Kearney & Gebert, 2009). Thus both reduced mismatch and greater educational diversity correlate with improved motivation and satisfaction, and subsequently improved innovation performance. These effects are moderated by acceptance by the management team, and the wider organisation (Alpkan, Bulut, Gunday, Ulusoy, & Kilic, 2010; Chi, Huang, & Lin, 2009). However, there has been no direct examination of the interaction between mismatch and educational diversity in either literature. Hypothesis 1c thus explicitly links educational
diversity and horizontal mismatch, and their interaction in the high-technology sector at the technical employee level:

**Hypothesis 1c.** Horizontal mismatch moderates the affect of technical employee educational diversity on innovation at the organisation level. The effects of educational diversity are stronger in more matched settings.

**Management Team Educational Diversity and Horizontal Mismatch Impact Innovation at the Organisation Level**

As at the employee level, educational diversity in the management team has been linked to improved innovation performance by, for example, Carpenter et al. (2004) and Hitt et al. (2001). This relationship between educational diversity and innovation performance has been decomposed by a number of authors (Talke, Salomo, & Rost, 2010). In particular, Barkema and Shvyrkov (2007) and Auh and Menguc (2005) explain that greater diversity brings together a wider range of skills, views, and ways of understanding and evaluating. These collectively contribute to higher levels of innovation via a greater diversity in managerial cognition and mental models, and greater scope for the creative development of ideas (Auh & Menguc, 2005; Carpenter & Fredrickson, J, 2001). This link is further supported by Dahlin et al. (2005) who explain innovation improvement from diversity in terms of enhanced ability to use information. Based on these findings educational diversity has been shown to have a significant effect on innovation performance distinct from other aspects of diversity (e.g. gender or age) (Dahlin et al., 2005). However, prior studies have not explored this relationship at the management team level in the high-technology sector. Hypothesis 2a thus targets education diversity specifically with respect to longitudinal innovation at the organisation level in the context of the high-technology sector:

**Hypothesis 2a.** High management team educational diversity has a positive affect on innovation at the organisation level.
At the management team level alignment between functional role and specific experience (functional and education) correlate with innovation performance (Bassett-Jones, 2005). Here, recognition of commonalities and awareness of differences are key to effectively leveraging performance benefits from diversity (McMahon, 2010). Thus Carpenter et al. (2004) highlights explicit recognition, incentivisation, and integration of diverse skills team background and experience as key moderators of management team demographic effects. This translates to the need to actively manage diversity through role assignment and leadership, as highlighted by both Auh and Menguc (2005) and McMahon (2010). As such, it is again possible to build on the labour economics literature to hypothesise a relationship between horizontal mismatch in the management team and innovation at the organisation level. However, no prior studies have directly examined this link at this level. Hypothesis 2b explicitly links reduced horizontal mismatch at the management team level to innovation at the organisation level in the high-technology sector.

**Hypothesis 2b. Low management team horizontal mismatch has a positive effect on innovation at the organisation level.**

Finally, as at the employee level, educational diversity and horizontal mismatch can be linked via common mechanisms of empowerment of diversity effects and recognition and incentivisation of individual staff (Carpenter et al., 2004; McMahon, 2010). Building on the same logic as Hypothesis 1c, Hypothesis 2c predicts a moderating relationship between horizontal mismatch and the impact of management team educational diversity effects.

**Hypothesis 2c. Horizontal mismatch moderates the affect of management team educational diversity on innovation at the organisation level. The effects of educational diversity are stronger in more matched settings.**
Alignment Between Technical Employee and Management Team Characteristics

Impact Innovation at the Organisation Level

Josh et al. (2003) amongst others (Kearney & Gebert, 2009; Raes, Heijltjes, Glunk, & Roe, 2011) highlight that alignment in strategic vision and understanding of company goals across organisational levels is key to company performance. In this context, diversity can have a detrimental effect on consensus formation and agreement (Auh & Menguc, 2005). Thus in order to achieve the performance benefits derived from alignment it is critical to actively manage diversity at each level (Faems & Subramanian, 2013; McMahon, 2010). For example, Milliken and Martins (1996) highlight how the positive effects of diversity on innovation can only be realised when coordination activities are correspondingly increased.

Alignment can be achieved in a number of ways e.g. through transformative leadership (Kearney & Gebert, 2009), all of which link to the key performance mechanisms: employee recognition, engagement, and job satisfaction (McMahon, 2010). These are particularly influential at the employee/management team interface (M. Joshi et al., 2003; Lankau et al., 2007). Gruman and Saks (2011) and Bassett-Jones (2005) link employee engagement to job satisfaction and improved innovation performance. At a fundamental level Kinicki et al. (2004) show that this performance improvement builds on trust in the management team and the employees’ belief that the supervisor knows the job to be done and is in the position to make informed and credible judgements. Further, Gruman and Saks (2011) highlight how effective coaching by the management team can foster engagement and instil confidence amongst employees. Thus the quality of the exchange relationship between management team and employees is both critical to innovation performance and dependant upon alignment between employee and manager in terms of understanding (Kearney & Gebert, 2009). This interpretation is further supported by Hislop et al. (2000) who highlight the importance of importance of hierarchical authority for empowering and implementing
employee innovation. Thus the management team’s ability to understand the employee’s; and the employee’s perception that the management team are credible thus moderate the wider effects on innovation performance (Kinicki et al., 2004; Simpson, 2009). We hypothesise that greater alignment in education diversity between levels will allow for better understanding and engagement across levels and thus moderate innovation performance (Hypothesis 3a). Further, reducing horizontal mismatch at both levels will also act on the understanding and engagement mechanisms to moderate innovation performance (Hypothesis 3b).

**Hypothesis 3a.** Alignment between management team and technical employee educational diversity has a positive impact on organisational performance. The effects of educational diversity are stronger in more aligned settings.

**Hypothesis 3b.** Alignment between management team and technical employee horizontal mismatch has a positive impact on organisational performance. The effects of horizontal mismatch are stronger in more aligned settings.

**SAMPLE AND ORGANIZATION**

We base our study on a longitudinal dataset of 8,350 Danish firms. The firms are observed from 2001 to 2010 and thus containing a panel structure. The data is sampled from the Integrated Labor Market database (IDA) supplied by the national Danish statistics bureau (Statistics Denmark) and provides firm and employee level register data. The firm level register data contain information on industry, export activities, the size of the firm, geographical location, revenue and profits. The employee level data contains information on education, salary, primary and secondary workplace, type of job and degree of unemployment. Merging firm and employee level data allows us to create firm level variables that describe the levels of education and horizontal mismatch within the firm. We observe firms with more than 10 full time employees to remove home offices and cottage industry. This provides us with 60,217 observations divided between 8,350 unique firms.
To measure the innovative performance of the firm we rely on patents as a proxy for innovation output. The patent data is provided by the Danish Patent and Trademark Office (DKPTO) and is matched to the firm level data using a unique firm identifier. The matching to IDA register data was done by DKPTO to ensure a high validity of the data.

Measures

**Organizational innovation:** The annual patent production of the firm is used as a proxy for organizational innovation. Patent data does not capture all innovation of the firm, but does provide an indication of the innovative output of the firm, particularly in technical industries. Unfortunately we do not have citation data not available, whereby we are unable to assess the quality or impact of firm innovation.

**Horizontal mismatch:** We use the employee level data on education and job title aggregated to the firm level to generate indicators on the overall level of educational diversity and horizontal mismatch on the firm level. Horizontal mismatch is calculated both for employees and managers separately. The IDA database provides both distinct education codes describing the title of the highest completed education, and a descriptive job title for each employee. The level of horizontal mismatch for managers is calculated as the share of employees in a management job with an education in business administration or management. For employees we focus on the horizontal mismatch of engineers. Engineers contribute highly to technical innovation, and provide a clear identification of education and job title. Similar to managers, the horizontal mismatch of engineers is calculated as the share of engineering jobs staffed by an employee with an engineering education. This is a ratio variable ranging from 0 to 1 in which high values indicate low levels of horizontal mismatch. We do not take engineering specialization into account as a large share of engineers has an
education classified as ‘general engineering’ or simply ‘Engineering Masters’, rather than as falling within a specific technical domain.

**Educational diversity:** For educational diversity we calculate a normalized Herfindahl-Hirschman Index (HHI) using education codes for employees and managers separately. For managers we focus those with a relevant education in business administration or management and classify each manager to their specific education. Similarly for employees, we classify each engineer in a non-management job to their specific education using the education codes from the IDA database. The HHI for educational diversity is normalized in order to present a higher value for high values of educational diversity.

**Alignment of horizontal mismatch:** Alignment between managers and employees is represented as the difference between the levels of horizontal mismatch. As horizontal mismatch is a ratio variable ranging from 0 to 1 these can be compared directly. We compute the alignment of horizontal mismatch as the difference between the ratio of horizontal mismatch of managers to that of employees. This value is normalized in order for the variable to show a high value for a strong alignment of horizontal mismatch between managers and employees.

**Alignment of educational diversity:** Similarly to the alignment of horizontal mismatch, the alignment of educational diversity compares the difference between two ratio variables ranging from 0 to 1. The alignment of educational diversity is computed as the difference between the ratio of educational diversity for managers and employees. Again this is normalized to provide a high value for stronger alignment of educational diversity.

**Control variables:** We employ a number of control variables across all models. We include the size of the firm (firmsize) measured as number of employees. This allow for an even comparison between firms of varying sizes and eliminates the effect of larger firms
potentially producing more patents. As our dependent variable is the patent production of the firm, we include controls for the number of lawyers in relation to the size of the firm (share_lawyers) as firms with a higher number of lawyers employed could potentially be more active in patenting. In addition we control for the share of employees with a doctorate in natural science (share_science) as this group of employees can contribute significantly to the patent production of the firm.

ANALYTICAL METHOD

Our dependent variable was the number of patents produced by the firm annually and following prior literature using this data we turned to count models for estimation (e.g. Hausman et al (1984)). The annual production of patents by the firm is estimated as an exponential function of the knowledge stock of firm employees and other characteristics Xit:

\[ E[p_{it} | X_{it}] = \lambda_{it} = \exp(X_{it}\beta + \gamma_t) \]

In which \( i \) identifies the firm, \( t \) the year, and \( \gamma_t \) measuring the mean overall patent production across time. The data is tested for overdispersion using the LaGrange Multiplier test as suggested by Cameron and Trivedi (1986), and for zero inflation using the Vuong test (Greene, 2012). As our data is overdispersed we find the negative binomial estimation to have a better fit in comparison to the Poisson estimation. The Vuong test points to an issue of zero inflation and hence we rely on a zero inflated negative binomial estimation to analyse our data. We test our hypotheses in four separate models; Model 1 focus on the educational diversity of managers and engineers, whereas models 2 and 3 focus on the interaction effects between educational diversity and horizontal mismatch for engineers and managers respectively. Model 4 focus on the alignment of educational diversity and horizontal mismatch.
RESULTS

We present the descriptive statistics in table 1. Within our sample, the median firm has a size of 206 employees and produces 0.3 patents annually. The indicators for educational diversity differs slightly between managers and engineers, however both normalized HHI show a substantial educational diversity in both job types. The pairwise correlations are presented in table 2, with no signs of high correlation between variables.

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<td>Insert Table 2 about here</td>
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Table 3 presents the results of our regression models, separated into 4 models. Model 1 focus on the direct effects of educational diversity and horizontal mismatch on organizational innovation. We find that increasing levels of educational diversity of both engineers and managers have a positive effect on organizational innovation, lending support to hypotheses 1a and 2a. Hypotheses 1b and 2b finds also support in model 1 as we find a positive and significant effect of low horizontal mismatch of both employees and managers on organizational innovation. Model 2 presents the interaction effect between horizontal mismatch and educational diversity for employees, however this does not produce any significant results. Hence we do not find any support for hypothesis 1c. Model 3 presents the interaction effect between horizontal mismatch and educational diversity for managers. In this we find a positive and significant result of the interaction, which indicates that lower levels of horizontal mismatch positively moderates the relation between educational diversity of managers and organizational innovation. Interestingly when including the interacted term in the model, we find a negative and significant estimation of horizontal mismatch of
managers. This contradicts our results in the remaining models and indicates that the benefits of low horizontal mismatch of managers are only present in firms with higher levels of educational diversity among the management. Model 4 is structured similar to model 1, however includes two variables for the alignment between educational diversity for managers and employees, and alignment between horizontal mismatch for managers and employees. We find a positive, significant result for the effect of both types of alignment on organizational innovation, supporting hypotheses 3a and 3b.

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Insert Table 3 about here

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DISCUSSION

The purpose of this study was to examine, both theoretically and empirically, the interconnected nature of educational diversity and horizontal mismatch across organisational levels, and their effect of innovation at the organisation level. In keeping with recent arguments (e.g. Hitt et al. (2001); Unger et al. (2011)), we conceptualise these factors as interconnected and significantly related to innovation performance. By considering these both amongst technical employees and the management team, we provide a more detailed examination of the interrelationships and consequences of educational diversity and horizontal mismatch on innovation. This closes a significant empirical gap in the human capital literature by employing a longitudinal dataset to identify time specific variations of educational diversity and horizontal mismatch and their effect on organizational innovation.

Theoretical Implications

First, we demonstrate that both high educational diversity and low horizontal mismatch amongst technical employees and the management team have a strong positive
effect on innovation at the organisation level. This confirms and extends prior research on the 
effects of educational diversity amongst technical employees. In particular, the findings align 
with and extend studies of individual teams (Kearney et al., 2009; Kearney & Gebert, 2009), 
as well as studies of diversity across the entire employee base (Østergaard et al., 2011). This 
closes the major empirical gap highlighted by both the review of Joshi and Roh (2009) and 
Østergaard et al. (2011). By demonstrating the link between horizontal mismatch and 
innovation at the organisation level this study explicitly connects horizontal mismatch and 
human capital theory. Despite the logical link between these areas implied by e.g. 
McGuinness and Sloane (2011), this relationship has not previously been described 
theoretically or empirically demonstrated. Here, findings align with studies at the workforce 
level (Nordin et al., 2010) but explicitly highlight the importance of horizontal alignment for 
organisations and human capital. This extends prior work on the affects of educational 
diversity and job role by introducing a additional dimension not previously described by 
human capital theory (Jiang et al., 2012). The interconnectedness between educational 
diversity and horizontal mismatch makes these factors even more inimitable than either in 
isolation. Failing to understand these interrelationships and their specific significance 
amongst technical employees and the management team, it is possible to misattribute 
antecedents of innovation within an organisation. Research should further study the 
relationships between different types of human capital and their alignment with job role. 

Second, we found that horizontal mismatch, particularly within the management team, 
moderates the effects of educational diversity. This points to interplay between human capital 
factors not fully described by current theoretical models. This aligns with the arguments 
outlined by Ployhart and Moliterno (2011) who describe the human capital literature as 
theoretically fractured. A further finding in this context is that the relationship between 
horizontal mismatch and educational diversity is not consistent across the two groups of
employees (contrast H1c and H2c). This points to the need for further exploration of how employee heterogeneity affects the emergence of particular aspects of organisational performance. Prior studies have tended to focus one or other group of employees e.g. top management teams (Carpenter et al., 2004). The interrelationship between these factors across employee groups suggests a more complex picture of human capital and highlights the need for greater connectivity within human capital theory. Research should further study the varying impact of human capital factors as well as their changing interactions across employee groups.

Finally, we have argued and shown that the interplay between horizontal mismatch and educational diversity in the management team and amongst technical employees has a significant impact on innovation at an organisation level. However, this relationship is not currently described by human capital theory. This is of particular significance given the conflicting affects of diversity, leadership, and alignment across organisational levels demonstrated by e.g. Faems and Subramanian (2013), Kinicki et al. (2004), and Kearney and Gebert (2009). This extends prior studies, which have focused on the impact of the top management team exclusively, as well as pointing to a more complex model of human capital across organisational levels. Research is needed to explore the variety of possible factors affecting this relationship.

**Managerial Implications**

The challenge of managing educational diversity, particularly, across organisational levels, is that its effects are both significant for innovation and also highly interconnected with other aspects of human capital. Consequently educational diversity and horizontal mismatch cannot easily be separated and are also dependant on alignment across organisational levels.
One important implication is that leveraging educational diversity as a means of innovation requires more than simply employing a diverse population of technical employees. It requires careful consideration of how these employees are matched to their job roles, how these roles are balanced across the population, and how this aligns with diversity and mismatch within the management team. This leaves the manager with the challenge of having to align diversity and mismatch across multiple dimensions, while still integrating more traditional guidelines, such as transformational leadership. For example an organisation with a highly diverse group of technical employees must consider if alignment is needed across organisational levels, within the technical employees only, or within both the management team and technical employee population. By modelling the mediating affects of these factors we showed that the practical consequences of alignment within and across these two groups of employees is critical to the innovation performance of an organisation.

**Limitations and Directions for Future Research**

In the current iteration of our estimations we do not correct for potential issues of endogeneity. In future research this should be investigated and any issues identified corrected. Due to the nature of the data and availability of data, the application of instrumental variable regression could solve potential issues. Alternatively a matched sample can be employed. In addition multiple robustness checks are required to test the validity of the findings presented in this paper. Potential robustness checks include standardizing the dependent variable and employing a linear regression model, a zero inflated Poisson model or a panel-level fixed effects specification with firm-level fixed effects.
Conclusion

In conclusion, the present study confirms the importance of educational diversity for innovation at the organisation level and identifies horizontal mismatch as a key construct not previously described by human capital theory. Importantly these factors both independently influence innovation and interact within and across organisational levels. This points to a more complex understanding of interconnected human capital within an organisation. We hope this study prompts researchers towards finer-grained examination of different forms of human capital, their interactions, and their mediating effects across organisational levels. In particular, the relationship between management team and educational diversity/horizontal mismatch within the technical employee group requires further investigation in order to derive potential best practices.
REFERENCES


Figure 1a: Causal model linking human capital and mismatch characteristics to organizational innovation

Figure 1b: Dimensions of mismatch and alignment considered in this study
Table 1 – Descriptive statistics

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Table 2 – Pairwise correlation matrix

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Table 3 – Results of zero inflated negative binomial regression

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* p<0.1, ** p<0.05, *** p<0.01