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Engineering students' learning during internships: Exploring the explanatory power of the job demands-control-support model

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Abstract

Background: Internships are highly relevant learning experiences for engineering students. However, such practice-based learning settings must be carefully designed to allow their learning potential to unfold.

Purpose: Exploring the job demands-control-support (JDCS) model, this study aimed to investigate how job demands, job control, and social support affect interns' use of different learning strategies.

Method: The study utilized data collected from a sample of engineering students ($n = 118$) who completed a required internship during their degree. The data were analyzed using a structural equation modeling approach including latent factors.

Results: Job demands were found to be a relevant and significant driver of students' shared regulation (e.g., asking for feedback), self-regulation (e.g., self-directed use of codified information), efforts to relate theory to practice (e.g., connecting workplace experience with theoretical knowledge), and the absence of avoidance of learning (e.g., lack of adaptation to work situations), but not of external regulation (e.g., asking for help to solve problems). Job control, however, was not found to be a positive or significant driver of student learning. Social support was found to be a relevant and significant predictor of external and shared regulation but not of the other learning activities.

Conclusions: This study provided mixed findings regarding key hypotheses central to the JDCS model, generating rather poor evidence supporting it. In fact, job demands, job control, and social support exhibited much less explanatory power than expected for engineering students' learning during internships.

KEYWORDS

internships, professional practice, self-regulated learning, informal learning

1 | INTRODUCTION

Internships are particular work engagements providing students with access to domain-specific industry experience during a limited time frame (Maertz, Stoeberl, & Marks, 2014). They are important curricular components included in

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many engineering degrees that allow students to gain practical experiences that go beyond more formal learning opportunities afforded by higher education institutions. On the one hand, internships aim at providing practice-based learning that connects areas of theory taught in institutions of higher education with areas of vocational practice that constitute workplaces outside of schools (Maertz, Stoeberl, & Marks, 2014; Resnick, 1987; Sides & Mrvica, 2017). On the other hand, internships give students access to technological advancements that are not yet incorporated in educational curricula, and this is particularly important in domains such as engineering that are subject to rapid developments (e.g., current digitalization trends; Harteis, 2018; Tynjälä & Gijbels, 2012). The overall aim of internships is to enable students to develop competences that prepare them to become competent professionals capable of coping with current and future job demands.

Research in the area of workplace learning reveals that participation in everyday working life provides immense potential for learning processes throughout workers' careers (Billett & Smith, 2014; Eraut, 2007; Harteis, Rausch, & Seifried, 2014). *How* and *what* can be learned in such situations is determined to a great extent by the interdependence of practices afforded by the particular workplace as well as the worker's participation in those practices (Billett, 2001, 2011). In other words, workplace learning is explained by both workplace characteristics and learner agency. Unfortunately, however, research that attempts to identify workplace characteristics conducive to learning as well as workers' strategies to deal with the practices afforded to them has usually been conducted with working populations that are either completing training in the vocational and training sector or have already completed their professional education (e.g., Janssens, Smet, Onghena, & Kyndt, 2017; Kärner, Minkley, Rausch, Schley, & Sembill, 2018; Rausch, 2013). Research with students with an internship in industry is scarce. Consequently, not much is known about what particular workplace characteristics are conducive to learning in internship contexts or how interns engage with workplace learning opportunities.

A central goal of this study was to understand more fully engineering students' learning in internships and to generate insights that might be used systematically to design internships that facilitate students' professional learning as much as possible. For this purpose, the job demands-control-support (JDCS) model was used to explore how well particular workplace characteristics affect students' active engagement in different learning strategies during their internship. The hypotheses derived were then empirically tested using a structural equation modeling (SEM) approach with a sample of Belgian engineering interns.

Before the empirical study is described and discussed, the JDCS model is presented, explaining workplace learning in terms of job demands, job control, and the role of social support. Then a set of five analytically distinct learning strategies are described in order to understand how engineering interns learn within practice settings.

2 | INTERNSHIPS AS ORGANIZED WORKPLACE LEARNING

2.1 | Explaining workplace learning through the JDCS model

Theoretical as well as empirical accounts suggest a range of positive effects of internships in general and in the domain of engineering in particular: In addition to knowledge-related outcomes (e.g., Renganathan, Ambri Bin Abdul Karim, & Su Li, 2012; Yin, 2009), engineering internships have been shown to increase students' motivation to continue their programs of study (Chesler, Arastoopour, D'Angelo, Bagley, & Shaffer, 2013), promote students' identity development (Dehing, Jochems, & Baartman, 2013), bridge gender stereotypes (Ortiz & Sriraman, 2015), and enable students to socialize with long-lasting industry contacts (Honda, Pazmino, Hickman, & Varma, 2015). Such positive effects of internships, however, should not be taken for granted. Instead, the material and social environment at work needs to actively support them (Billett, 2001, 2011; Lee, Yoo, Lee, Park, & Yoon, 2019).

Within the workplace learning literature, no prevailing model or theory exists, which explains how workplaces support employees' learning and development. Most discourses are rooted within the sociocultural account focusing on learners' situated enculturation into existing communities of practice through active participation as legitimate peripheral participants (Hager, 2013; Lave & Wenger, 1991; for the engineering context see, e.g., Gilbuena, Sherrett, Gummer, Champagne, & Koretsky, 2015). Based on these ideas, Fuller and Unwin (2004, 2013) derived a list of characteristics that help to describe workplaces either as restrictive or expansive learning environments. For instance, while expansive workplaces allow learners to participate in different communities of practice, restrictive workplaces discourage such boundary crossing. Although these models are useful for understanding the nature of workplace learning, they remain rather abstract and do not readily allow for testable hypotheses to be derived.

A much more specific account linking workplace characteristics to learning, however, is the job demands-control model as well as the later extended JDCS model (Johnson & Hall, 1988; Karasek, 1979). Both models make strong propositions concerning which workplace characteristics foster learning and can thus be used to derive hypotheses that can be used in empirical studies. It was therefore decided to employ them as a starting point to investigate the workplace characteristics conducive to learning in engineering internships.

The original version of the job demands-control model described work environments according to the mental work load (i.e., job demands) as well as the decision latitude (i.e., job control) a job holder faces in a particular workplace (Karasek, 1979, 1998; Karasek & Theorell, 1990). According to the model, workplaces are conducive to learning when workers are required to engage in highly demanding tasks and problems that simultaneously offer sufficient degrees of freedom, allowing them to decide how to engage with these activities. Karasek (1979, 1998) hypothesized that incumbents of such workplaces more often exhibit active learning in comparison with workers who face low demands and low control. Active learning, thus, refers to all kinds of learning strategies initiated by the learners themselves (Taris & Kompier, 2005; see also Section 2.3 for a specification of the concept in the context of internships).

The rationale behind this learning hypothesis is that incumbents may only experience incentives to engage in active learning as long as they are regularly confronted with novel or challenging work situations that require them to apply appropriate coping mechanisms. New coping mechanisms, however, might only be developed as long as the incumbents are afforded with discretion to utilize available resources (e.g., manuals, textbooks) and to actively experiment with new task and problem-solving approaches. Without sufficient job control, incumbents will be forced to fall back into already familiar behavioral patterns because they will have missed the opportunity to construct new knowledge.

Since the work environment involves not only task-related resources but also social ones, Johnson and Hall (1988) added the component of social support to Karasek's original model and thereby formulated the JDCS model. Social support refers to relations between colleagues and supervisors or mentors, manifesting in assistance in problem-solving situations. If an individual perceives social support, they can rely on others when facing tasks and problems that cannot be solved alone. Furthermore, access to colleagues, supervisors, or mentors allows incumbents to discuss and thereby further develop newly acquired working strategies as well as to receive feedback about the efficacy and efficiency of both old and new work behaviors that would not have been available otherwise (Fischer, Goller, Brinkmann, & Harteis, 2018). Feedback in particular has been shown to be highly relevant for professional learning (Ericsson, Krampe, & Tesch-Römer, 1993; Kyndt, Dochy, & Nijs, 2009; Tannenbaum, Beard, McNall, & Salas, 2010) since it essentially works as a catalyst for reflection processes (Schley & van Woerkom, 2014). Thus, Karasek's (1979) original learning hypothesis was in need of extension; the implication now is that job demands, job control, and social support are drivers of workers' active learning. A visualization of the JDCS model, including the extended learning hypothesis, can be found in Figure 1.

Although Karasek (1998) later explicitly discussed the learning hypothesis, this discussion was only an aside to his first description of the job demands-control model which was originally developed to explain mental strain from work (Karasek, 1979). Only later was the model rediscovered to explain and investigate workplace learning. In comparison with other theories, the JDCS model (a) offers a strong rationale for why particular workplace characteristics explain

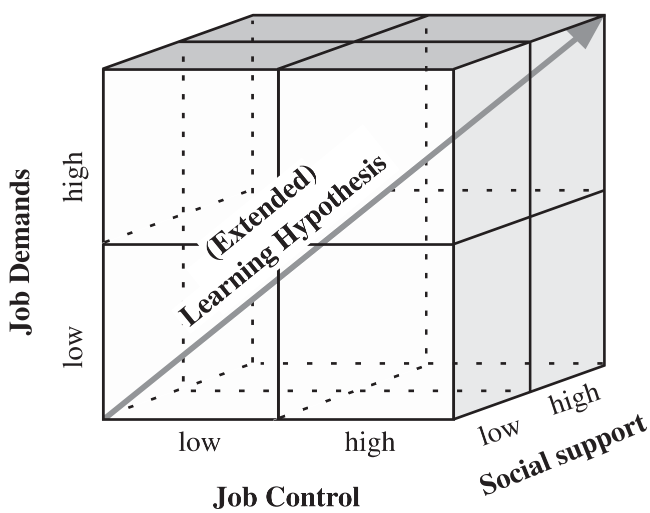

FIGURE 1 Learning hypothesis of the JDCS model

how and why workers learn at work, and (b) allows a set of testable hypotheses to be derived. Unfortunately, the model has primarily been used to discuss the learning of regular workers, not interns. It, therefore, remains to be seen whether its three main dimensions have explanatory power to predict intern engagement in active learning at work.

2.2 | Empirical evidence regarding the JDCS model

Although the JDCS model is conceptually well established within the workplace learning literature, empirical findings about its validity are still relatively scarce. The majority of published studies have used proxy measures like self-efficacy beliefs or perceived work challenges as dependent variables that hardly capture Karasek's (1979, 1998) notion of active learning strategies (Taris & Kompier, 2005). Hence, so far only a limited set of studies have generated valid evidence of how job demands, job control, and social support predict workers' engagement in active learning. The evidence brought forward by these studies will now briefly be reviewed (see Taris & Kompier, 2005; Wielenga-Meijer, Taris, Kompier, & Wigboldus, 2010, for more detailed discussion of studies on the JDCS model including a range of different outcome variables).

A few studies focused only on the original job-demand-control model and did not include social support as a variable in their investigations. Two of these studies found evidence supporting Karasek's original learning hypothesis: Workers who experience high job demands as well as high job control engage to a greater extent in efforts targeting the enlargement of their skill and knowledge repertoire ($n = 311$ novice machine operators and office technicians, Taris & Feij, 2004; $n = 2{,}212$ workers of different domains, de Witte, Verhofstadt, & Omey, 2007). Two other studies, however, found a positive effect of job control only ($n = 876$ school teachers, Taris, Kompier, de Lange, Schaufeli, & Schreurs, 2003; $n = 4{,}636$ workers of different domains, Bergman et al., 2012). Contrary to the expectations of these latter researchers, job demands were found to be a weak negative predictor of learning in the study conducted by Taris et al. and had no effect in the study conducted by Bergman et al.

The findings from studies that included all three JDCS dimensions in their investigation have proved to be slightly more ambivalent. Full support for the extended learning hypothesis of the JDCS model could be found only in the study of Raemdonck, Gijbels, and van Groen (2014). In their study of 837 workers from different sectors, job demands, job control, and social support positively predicted active learning. However, job demands exhibited stronger effects in comparison with job control and social support. The studies of van Mierlo, Rutte, Seinen, and Kompier (2001) and de Lange et al. (2010) as well as of Gijbels, Raemdonck, Vervecken, and van Herck (2012) found positive effects only of job demands and job control on the learning of supermarket employees ($n = 138$), workers of different sectors ($n = 1{,}237$), and information and communications technology (ICT) workers ($n = 73$). In two studies on nurses, active learning was predicted by job control as well as social support ($n = 372$, Berings, van Veldhoven, & Poell, 2010; $n = 210$, van Doorn, van Ruysseveldt, van Dam, Mistiaen, & Nikolova, 2016). In the latter study, job control exhibited a much stronger effect on workers' learning than social support. Both studies failed to identify job demands as a significant driver of workplace learning behavior. Evidence for one particular JDCS dimension was found only in two studies. Kwakman (2001) investigated the learning of 542 secondary teachers: In her sample, only the experienced emotional demand at work predicted teacher engagement in active learning efforts. Gijbels, Raemdonck, and Vervecken (2010) investigated the learning hypothesis in a sample of 115 students who worked part-time: Although all three dimensions positively correlated with their measure of workplace learning, only the correlation with job demands reached significance.

Although most studies did not find full support for Karasek's learning hypothesis, evidence exists that workers engage more often in active learning efforts in workplaces that afford high job demands and high job control. Social support, on the other hand, was found to be an important driver of worker learning in only three of the reported studies. Unfortunately, all of the reported studies were conducted with samples of regular workers, not with interns. In addition, the studies drew on samples from a range of different domains (nursing, teaching, machine operating, etc.) that are not closely related to the domain of engineering. So it is still unknown whether the learning hypothesis of the JDCS model also holds for engineering students completing an internship.

Only recently has engineering students' learning during internships been investigated from the perspective of the JDCS model (Gijbels, Harteis et al., 2014; Gijbels, Donche, van den Bossche, Ilsbroux, & Sammels, 2014). This research, however, was limited to a validation of the research instruments within the context of engineering education and an exploration of the relations between the different variables in the JDCS model, students' learning activities, and students' perceived competences. The results from these studies indicate that the variables studied are indeed related, but the question of whether the variables in the JDCS model—that is, job demands, job control, and social support—can also explain or predict engineering interns' learning remains unanswered so far. Nevertheless, based on the theoretical framework, this study hypothesized that all three JDCS dimensions are positively related to intern workplace learning during internships. This hypothesis is supported by more general notions within the literature that internships should afford students with (a) a variety of challenging tasks that fit their interests and skills (Maertz et al., 2014), (b) sufficient autonomy so that they can use their existing knowledge to engage in assigned work activities (McHugh, 2017), and (c) guidance of workplace mentors who offer scaffolding and feedback during problem-solving attempts, especially in the case of failure (Maertz et al., 2014; McHugh, 2017; Virtanen, Tynjälä, & Eteläpelto, 2014). We, therefore, believe that the subjective perception of job demands, job control, and social support are relevant workplace characteristics linked to interns' learning. Interns are usually highly motivated students who want to engage in a range of relevant and challenging tasks, who want to use their knowledge and therefore require some kind of discretion, and who need support from more experienced colleagues who know how to deal with the challenges they face during their internship so that they can acquire new knowledge and skills for their later career.

As pointed out by Taris and Kompier (2005), the notion of active learning within Karasek's learning hypothesis is rather unspecific. This limitation might explain why most studies on the JDCS model operationalized learning using only a single scale measuring the concept in a rather abstract way. Very few studies defined concrete workplace learning efforts that were separately operationalized (e.g., active information seeking in the case of Bergman et al., 2012, or visiting information meetings in the case of Berings et al., 2010). This might be one reason why some studies failed to find full evidence supporting the JDCS model. More detailed measures of concrete learning activities, however, could provide a much finer picture of how the JDCS dimensions affect learning at work. The next section, therefore, elaborates on a conceptual framework that allows different learning strategies exhibited by students during their internships to be conceptualized and operationalized.

2.3 | Learning activities during internships

Learning at work is mostly informal and implicit in nature. It is a product of workers' participation in work practices (Billett, 2004; Hager, 2013). More concretely, it is the daily tasks and problems in which individuals engage, including the social interactions required to take care of work challenges that allow them to acquire experiential knowledge (Ericsson, 2018; Gruber, 1999). At the same time, however, learning at work can also be more explicit and active in nature (Eraut, 2000). Workers can agentically seek out either personal or material resources for help to actively understand work-related phenomena, deliberately reserve time for reflection of experienced episodes, or even experiment with new solutions to a common problem (Goller, 2017).

A typology of how learning at work can be conceptualized in the context of internships has been developed by Oosterheert and Vermunt (2001). Both authors empirically examined how interns engaged with the tasks and problems afforded during their internships. Using a theoretical framework based on the assumption that students differ due to their basic understanding of how learning works (e.g., Hofer & Pintrich, 1997; Vermunt, 1996) and their self-image as a learner (e.g., Hollingsworth, 1989) as well as their dispositions toward knowledge and emotion regulation (e.g., Payne, Youngcourt, & Beaubien, 2007), Oosterheert and Vermunt found evidence that students exhibit different learning strategies within the context of internships (see also, e.g., Donche, Endedijk, & van Daal, 2015; Endedijk, Donche, & Oosterheert, 2014). Differences occur in terms of how students attribute relevance to available learning resources like their own experience, mentors and colleagues, or codified information in the form of journals and textbooks, and consequently how they actually use these resources for their knowledge and emotion regulation.

The original findings of Oosterheert and Vermunt (2001) were based on interviews with student teachers who did their internships in schools; these findings were later successfully adapted to the engineering context by Gijbels, Donche, et al. (2014). These authors argue that five analytically different ways explain how engineering students regulate their learning in internship situations. On the one hand, both *external regulation of learning* and *shared regulation of learning* are concerned with students' efforts to use the expertise of other individuals present in the workplace. On the other hand, *self-regulation of learning* as well as *actively relating theory and practice* are strategies students independently used in their learning. The last strategy (*avoidance of learning*) does not describe learning as such but rather students' active efforts to avoid knowledge regulation. A more detailed description of these five learning activities can be found in Table 1.[1]

Each of these five dimensions tapping regulation and learning activities can be understood as a distinct way to learn in workplace situations in general and in internships in particular. By employing this multidimensional perspective instead of conceptualizing workplace learning as a single overarching construct, a much more detailed picture of student learning during internships can be obtained. This is relevant since learning in work contexts often remains

TABLE 1 Learning activities used by engineering students in internship settings

Learning activity	Description of dimensions
External regulation of learning	Concerning learning activities in which interns actively approach their mentors as external sources for the regulation of their work or learning activities. Students might, for instance, ask their mentors for practical suggestions in the face of problems or explanations for certain work-related phenomena.
Shared regulation of learning	Concerning learning activities in which interns purposefully approach more experienced colleagues for practical suggestions and develop general views on engineering. Furthermore, this regulation type includes students asking their colleagues for feedback about their work performance.
Self-regulation of learning	Concerning learning activities in which interns try to solve problem situations on their own. For instance, students might seek information in codified knowledge sources like books or journals. However, this dimension also comprises learning via experimentation or through simple trial and error.
Actively relating theory to practice	Students' active efforts to connect their workplace experience during the internship with conceptual and theoretical knowledge learned at university or in other contexts. This kind of regulation includes two general directions: Students might actively apply theory to solve tasks and problems at work or they might agentically try to understand work-related phenomena based on their theoretical background.
Avoidance of learning	This dimension describes a lack of adaptation to challenging situations at work. This maladaptive kind of regulation comprises students' strategies to avoid reflections about negative work experiences. Typically, students who engage in avoidance of learning try to displace thoughts about mistakes or other kinds of malpractice.

unnoticed due to its informal and implicit nature. Describing concrete activities, however, should make learning at work more visible and empirically assessable. Perhaps even more importantly, the proposed distinction also allows testing of whether the dimensions of the JDCS model predict different kinds of students' active workplace learning activities. Although job demands and job control should be important predictors for all learning activities, this may not be the case for the social support dimension. For instance, both *external* and *shared* regulations of learning require the support of more experienced others. It follows that existing social support should be more important for these two learning activities than for the others. Social support, however, might be of less importance for s*elf-regulation* as well as for *actively relating theory to practice* as these learning activities do not necessarily require the learner to engage with coworkers. The hypothesized relationship between social support and the *avoidance of learning* is less clear. However, one could argue that a supporting culture in which coworkers regularly encourage interns to reflect on their work experiences may actually prevent them from engaging in this maladaptive regulation process.

These dimensions of learning activities are largely compatible with other models of work-related learning (e.g., Eraut, 2007; Estabrooks et al., 2005; Froehlich, Beausaert, & Segers, 2017; Lee et al., 2019; Pool, Poell, Berings, & ten Cate, 2016). They all emphasize the experience that individuals obtain through direct engagement in work tasks and the learning opportunities that arise through social interactions with colleagues or other work-related stakeholders as well as the way that learners might use codified material like books or journals to acquire more conceptual knowledge. At the same time, however, the conceptualization of Gijbels, Donche, et al. (2014) has been developed explicitly for engineering students in internship contexts and therefore promises to capture their learning most appropriately.

In summary, theoretical and empirical evidence suggests that interns differ in how they learn: Which of the five learning activities described are applied by a particular student might vary among work environments that differ in terms of job demands, job control, and social support. Therefore, any study investigating how different workplace characteristics explain interns' workplace learning should not neglect these regulation processes. Studies that incorporate students' different approaches to workplace learning allow a finer grained picture of students' knowledge construction during internships to be obtained and, therefore, add significantly to the research literature. Furthermore, insights thus obtained might help to design internships that facilitate learning.

3 | RESEARCH QUESTIONS

Considering the theoretical framework sketched out in the previous section, the question arises of how the three JDCS dimensions explain how engineering students learn during their internships. Learning in this context is understood as students' engagement in the five learning activities introduced above: *external regulation of learning*, *shared regulation* *of learning*, *self-regulation of learning*, *actively relating theory to practice*, and *avoidance of learning*. Thus, the following main research question guided this study:

1. How do job demands, job control, and social support explain how engineering students learn during their internships?

The JDCS model theorizes that it is the combination of job demands, job control, and social support that explains worker engagement in learning. The existing empirical findings are somewhat ambivalent and present only some evidence in favor of the comprehensive hypothesis that the combination of the three factors is relevant for learning. In line with prior studies, however, we assume less strictly that the three JDCS dimensions might each predict students' learning during internships independently. Thus, the following three hypotheses concerning this research question can be derived:

H1 *Job demand positively relates to all five learning activities.*

H2 *Job control positively relates to all five learning activities.*

H3 *Social support positively relates to all five learning activities.*

The previous section briefly acknowledged that the three JDCS dimensions might predict the five learning activities to a different extent. Since this notion has not yet been supported by empirical evidence, it was not included in the hypotheses. Instead, a second research question follows this path in a more exploratory manner:

2. In what ways do job demands, job control, and social support explain the five learning activities differently?

4 | METHOD

4.1 | Study design and sample

Empirical data were collected in Flanders (the Dutch-speaking area of Belgium) involving a sample of engineering students who completed an obligatory internship during their degree. The sample originally comprised 121 engineering students (majoring in electromechanical engineering, electronic engineering, or chemical engineering) in the third year of their bachelor program at a university college (University of Applied Science) who completed a long-term internship and were asked to complete a questionnaire after their internship. Three students did not answer most of the questions and were consequently removed from the data set. Within the remaining cases, there were only a few instances of missing data, and these were treated with expectation maximization imputation. The final data set consisted of 118 students who were predominantly Caucasian, on average 22.5 years old ($SD = 2.26$), and mostly male (19 females). All students participated voluntarily.

The data used in this study are based on a convenience sample. For this reason it cannot strictly assumed to be representative for the underlying student population. However, the student characteristics reported describe the sample as relatively typical for the population based on our experience.

The students completed their long-term internship in different organizations in Belgium that accommodated their majors. The internships were unpaid and lasted on average 2–3 months. However, a few students undertook internships that lasted between 6 and 12 months. No direct cooperation existed between the hosting organizations and the university. Hence, internships did not follow any externally defined workplace learning curriculum, and it was the hosting organizations' sole responsibility to structure the work and learning opportunities for their interns.

4.2 | Instruments

The three dimensions of the JDCS model were measured using Dutch self-reporting scales composed and validated in workplace learning contexts (see, e.g., Gijbels et al., 2010, 2012). Three scales with four items each fitting the engineering context were selected for the purpose of this study. Students' learning activities were measured using an adapted version of the Inventory Learning to Teach Process (Oosterheert, Vermunt, & Denessen, 2002) and its validated Dutch version (Donche & van Petegem, 2005). Five appropriate scales with four items each were selected and adapted to the domain of engineering. Respondents could answer each item on a 7-point Likert scale (1 = "Very few opportunities" to 7 = "A lot of opportunities" for the job control scale; 1 = "Entirely disagree" to 7 = "Totally agree" for all other scales). Since this study was interested in students' active learning activities and not the avoidance of learning, it was decided to reverse this scale, thereby focusing on the absence of such counterproductive knowledge construction and regulation. Subsequently, the scale was renamed as the "Absence of avoidance of learning." A sample item from each scale used in this study can be found in Table 2.

To check the psychometric quality of the measurements, two independent confirmatory factor analyses (CFA) were estimated. The first CFA tested the validity of the JDCS scales; the second investigated the learning activities scales. Following Westland's (2010) recommendations, the sample size requirements to estimate those two CFAs were fulfilled. All required statistical calculations were obtained using R 3.4.3 (R Core Team, 2017), including the packages psych 1.7.5 (Revelle, 2017) and lavaan 0.5.23 (Rosseel, 2012).

Both CFAs were estimated using robust ML estimation with Satorra-Bentler χ^2 correction (Satorra & Bentler, 1994), robust *SE*, and scaled fit indices. The following cutoff values were used as criteria for evaluating the model fit (see Bowen & Guo, 2012; Hair, Black, Babin, & Anderson, 2014; Tabachnick & Fidell, 2007): $\chi^2/df < 3.00$, CFI > 0.90, RMSEA < 0.07, and SRMR < 0.08. In addition to these fit indices, composite reliabilities were calculated to examine the scales' internal consistency (see Table 2). The CFA for the JDCS scales resulted in the following values: $\chi^2_{\text{SB}}(51) = 79.389$, $p = .007$, $\chi^2_{\text{SB}}/df = 1.557$, CFI = 0.910, RMSEA = 0.069, and SRMR = 0.075. Based on these criteria, the measurement model of the JDCS dimensions showed an acceptable fit. The composite reliabilities were expected to be above 0.70 or at least 0.60. This was the case for all JDCS scales (see Table 2). The second CFA checking the learning activities scales indicated a slightly better fit: $\chi^2_{\text{SB}}(160) = 206.716$, $p = .008$, $\chi^2_{\text{SB}}/df = 1.292$, CFI = 0.911, RMSEA = 0.050, and SRMR = 0.074. The composite reliabilities for the scales s*elf-regulation* and *theory-to-practice* were relatively low but still above the minimum cutoff value of 0.60 (see Table 2). Based on these findings it can be argued that the measurement instrument is suitable to be used for further analyses.

TABLE 2 Dimensions, sample items, descriptives, and composite reliabilities for each scale

Scale	No. of items	Item example	Composite reliability
Job-demands-control-support model dimensions			
Job demands	4	My job requires me to tackle work-related problems within a limited time frame.	0.76
Job control	4	To what extent do you get the chance to determine yourself how much work you take on during a certain time period?	0.82
Social support	4	I can easily contact my mentor when I want feedback about my performance.	0.74
Adapted version of the Inventory Learning to Teach Process			
External regulation	4	I try to find out what things my mentor would have taken into account for her/his decision in my situation.	0.76
Shared regulation	4	Through discussions with experienced colleagues during my internship, I develop my own views about ways of working.	0.80
Self-regulation	4	I try to find answers to my questions about my work during my internship by consulting the literature on my own.	0.66
Relating theory to practice	4	I try to connect work experiences of my internship with theoretical knowledge.	0.64
Absence of avoidance of learning	4	I search for the cause of a bad work experience during my internship.	0.86

4.3 | Analyses

To answer the research questions, a SEM using the three dimensions of the JDCS model as predictors was estimated for each of the five learning activities as dependent variables employing a partial least squares (PLS) estimation approach. PLS-based SEM allows testing of how a range of predictors explains a criterion like a normal ordinary least square (OLS) regression. In fact, PLS-based SEM uses OLS to estimate path coefficients. At the same time, however, PLS-based SEM allows estimation of relationships between unobserved latent constructs that are specified through a measurement model (see Hair, Hult, Ringle, & Sarstedt, 2014). This is not possible with standard OLS regression analysis. Since this study was interested in latent constructs, PLS-based SEM was selected as the most appropriate type of analysis.

As argued above, the JDCS model theorizes that it is the combination of job demands, job control, and social support that explains worker engagement in learning. Within a SEM regression framework such a proposition could be tested using interaction effects. Since all learning activities are regressed on three workplace characteristics, four interaction terms would have to be included in each analysis (*Job demands* × *Job control*, *Job demands* × *Social support*, *Job control* × *Social support*, *Job demands* × *Job control* × *Social support*). Since this study is based on only 118 usable cases, it was decided not to do so: First, including the four interaction effects would significantly reduce the power to detect the three main effects (*Job demands*, *Job control*, *Job support*). Second, in general, large samples are required to detect interaction effects because small samples provide only low power for their detection (Cohen, Cohen, West, & Aiken, 2003). To avoid futile power loss and to maximize power to detect the three main effects described in our hypotheses, each learning activity was, therefore, separately regressed on the three JDCS dimensions without interactions. Figure 2 illustrates the five models estimated using PLS-based SEM. In line with other studies (e.g., Raemdonck et al., 2014; van Mierlo et al., 2001), findings in which all three JDCS dimension were found to positively predict learning are interpreted as supporting the extended learning hypotheses of the JDCS model.

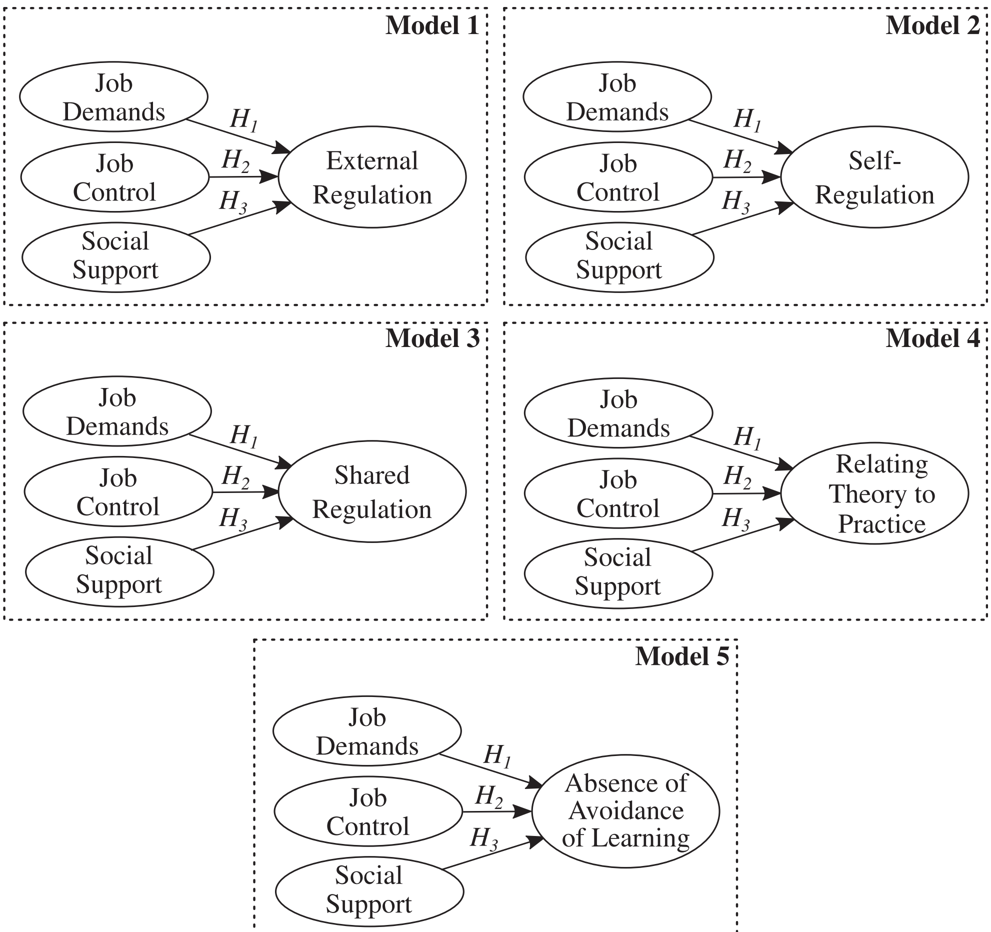

FIGURE 2 Estimated models

The PLS-based SEM regressions were estimated using R's plspm 0.4.9 package (Sanchez, Trinchera, & Russolillo, 2017). Following the recommendation of Hair, Hult, et al. (2014), the path weighting scheme was used for estimation. To test whether the regression coefficients obtained were significantly different from zero, bootstrapping with 5,000 resamples was applied (sampling with replacement). PLS-based SEM provides scholars with standardized regression coefficients (β) including corresponding p values for each predictor in the model as well as R^2 as the coefficient of determination. The interpretation of these is identical to that obtained from normal multiple regressions. Following Chin (1998, 2010), regression coefficients above .20 or, even better, .30 are considered to indicate substantial and meaningful relationships, and R^2 values of .19, .33, and .66 are described as small, medium, and large effects, respectively.

5 | RESULTS

5.1 | Descriptives

Table 3 shows the means (M) and standard deviations (SD) of all scales. All observed means were slightly above the theoretical midpoint of the 7-point Likert scale used ($M = 4$). The highest observed SD was 1.23 and the lowest 0.74, indicating sufficient variability in the data set.

On average, students rated their workplace most highly in terms of job control ($M = 5.32$, $SD = 1.02$). Job demands ($M = 4.96$, $SD = 0.89$) were ranked second, and social support ranked last ($M = 4.76$, $SD = 1.17$). It should, however, be emphasized that the mean differences observed between the different JDCS dimensions were relatively small. Similarly, the means of the learning activities do not show meaningful differences. They suggest that learning based on self-regulation ($M = 5.08$, $SD = 0.90$) or efforts to relate theory with the experienced practice ($M = 4.86$, $SD = 0.74$) were exhibited slightly more often than learning activities that make use of mentors ($M = 4.55$, $SD = 1.08$) or other colleagues at work ($M = 4.49$, $SD = 1.23$). In addition, avoidance of learning was relatively uncommon ($M = 5.11$, $SD = 1.12$). However, the reported mean differences are small.

The correlations between all scales are also depicted in Table 3. Within the JDCS dimensions job demands and social support were significantly and positively correlated ($r = .21$, $p = .021$). However, the other two correlations did not reach significance. The correlations between the different kinds of regulation were all significant and positive ($r = .26$–$.59$, all $p < .05$), indicating that students who engage more often in one kind of regulation also more often engage in each of the others. Job demands are significantly and positively correlated to all kinds of regulation processes ($r = .27$–$.46$, all $p < .05$) except external regulation. External regulation, however, was significantly and negatively correlated with job control ($r = -.19$, $p = .042$). All other correlations with job control were insignificant. Social support significantly and positively correlated with external regulation ($r = .36$, $p < .001$), shared regulation ($r = .38$, $p < .001$), and efforts to relate theory with the experienced practice ($r = .22$; $p = .002$).

TABLE 3 Means, standard deviations, and correlations of all scales used in this study

	Descriptives		**Correlations**							
Scale	***M***	***SD***	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
1. Job demands	4.96	0.89	–							
2. Job control	5.32	1.02	.18	–						
3. Social support	4.76	1.17	**.21**	−.05	–					
4. External regulation	4.55	1.08	.12	**−.19**	**.36**	–				
5. Shared regulation	4.49	1.23	**.27**	−.10	**.38**	**.55**	–			
6. Self-regulation	5.08	0.90	**.32**	.11	.12	**.26**	**.30**	–		
7. Relating theory to practice	4.86	0.74	**.29**	.05	**.22**	**.34**	**.35**	**.59**	–	
8. Absence of avoidance of learning	5.11	1.12	**.46**	.09	.16	**.47**	**.37**	**.43**	**.38**	–

Note: Product–moment intercorrelations are shown; all correlations are estimated using manifest mean scores of the corresponding scales. Correlation values given in bold are significant at the $p < .05$ level.

TABLE 4 PLS-based regression analyses summary for JDCS dimensions predicting each learning activity

Predictor	External regulation		Shared regulation		Self-regulation		Relating theory to practice		Absence of avoidance	
	β	p	β	p	β	p	β	p	β	p
Job demands	.18	.128	.26**	.004	.29**	.004	.35*	.001	.45***	<.001
Job control	−.18*	.026†	−.11	.139[a]	.07	.316	.07	.320	.07	.278
Social support	.44***	<.001	.38***	<.001	.17	.224	.20	.107	.22	.112
R^2	.314		.273		.153		.209		.313	

Note: β = Standardized regression coefficients estimated using PLS-based SEM; p = p value testing whether the standardized regression coefficients are larger than zero (one-tailed tests); R^2 = coefficient of determination.

[a]Based on the theoretical framework described in Section 2, all coefficients were assumed to be positive. Strictly speaking, this means that the p values of each negative coefficient had to be 1. However, for information purposes, the p values obtained from the software package are reported here (indicating the error probability for an assumed negative effect).

*$p < .05$; **$p < .01$; ***$p < .001$.

5.2 | Regression analyses

The results of the PLS-based regression analyses are presented in Table 4. As described in Section 4, each of the three JDCS dimensions was regressed on the different learning activities. The results are described sequentially.

Job control and social support significantly predicted students' external regulation: The less control ($\beta = -.18$, $p = .026$) as well as the greater social support ($\beta = .44$, $p < .001$) they experienced during their internships, the more often students engaged in external regulation processes. The experience of job demands, however, did not have any significant effect on their engagement in external regulation processes ($\beta = .18$, $p = .128$). The three job characteristics explained 31% of the variance of external regulation. Students' engagement in shared regulation was positively and significantly predicted by the experience of high job demands ($\beta = .26$, $p = .004$) and extensive social support ($\beta = .38$, $p < .001$). Job control, however, was not significantly related to this learning approach ($\beta = -.11$, $p = .139$). In total, 27% of the variance of shared regulation was explained by the three variables. Self-regulation strategies were significantly and positively predicted only by job demands ($\beta = .29$, $p = .004$). In other words, the higher the experienced job demands were at work the more self-regulation processes students exhibited during their internships. Neither job control ($\beta = .07$, $p = .316$) nor social support ($\beta = .17$, $p = .224$) affected such self-regulatory learning processes. Only 15% of self-regulation's variance was explained by all three variables included in this study. Students' efforts to relate theoretical knowledge with experiences during their internship were positively predicted by job demands ($\beta = .35$, $p = .001$). Job control ($\beta = .07$, $p = .320$) and social support ($\beta = .20$, $p = .107$), however, did not affect this learning approach ($R^2 = .21$). Students tended not to avoid learning, especially in work environments that were particularly demanding ($\beta = .45$, $p < .001$). Job control ($\beta = .07$, $p = .278$) and social support ($\beta = .22$, $p = .112$), however, did not significantly affect the absence of avoidance of learning within the sample. In total, 31% of this learning activity's variance is explained by the three JDCS dimensions.

6 | DISCUSSION

6.1 | Workplace characteristics conducive to learning during internships

This study investigated how different workplace characteristics explain differences in how engineering students learn during internships. The prominent JDCS model (Johnson & Hall, 1988; Karasek & Theorell, 1990) was used as the theoretical background to derive workplace characteristics that are assumed to foster learning during internships. Based on the model, it was hypothesized that interns learn best in workplaces that simultaneously afford high job demands, high job control, and strong social support. In light of the research conducted by Oosterheert and Vermunt (2001), it was furthermore argued that students might engage in different learning activities during their internships. Based on the findings of Oosterheert and Vermunt as well as those of Gijbels, Donche, et al. (2014), five kinds of learning activities have been distinguished in this study: (a) external regulation, (b) shared regulation, (c) self-regulation, (d) relating theory to practice, and (e) absence of avoidance of learning. It was suggested that the JDCS dimensions are all positively related to these processes (Research question 1, Hypotheses 1–3). Subject to more exploratory research was the question to what extent do the JDCS dimensions explain the different learning activities differently (Research Question 2).

The results indicated a mixed picture that is not fully in line with the JDCS model. In fact, the three JDCS dimensions predicted quite differently how students learn during internships in the engineering context. Not one of the five learning activities was predicted by all three dimensions as hypothesized but partial confirmation was found for the importance of at least one predictor in the explanatory JDCS model. The findings are eplored in more detail below.

The results of this study could not fully confirm Hypothesis 1. Although job demands were found to be a relevant and significant driver of students' shared regulation, self-regulation, efforts to relate theory to practice, and the absence of avoidance of learning, this dimension was not found to affect external regulation. More specifically, interns more often (a) engaged in activities in which they actively approached more experienced colleagues for practical suggestions or the development of general views concerning engineering, (b) tried to solve problems on their own using information-seeking or trial-and-error approaches, (c) attempted to connect knowledge learned at the university with experiences from their internships, and (d) averted maladaptive behaviors like suppressing reflections on negative work experiences in internship contexts they perceived as mentally more demanding in comparison with work contexts perceived as less demanding. This observation is in line with the JDCS model as well as previous findings that indicate the important role of tasks that are demanding and challenging (e.g., de Lange et al., 2010; de Witte et al., 2007; Maertz et al., 2014). At the same time, however, job demands did not predict students' external regulation. In other words, interns tended not to use their formal mentors as learning resources in highly demanding workplaces. This finding, then, is not in line with the predictions of the JDCS model. It might be speculated that this result relates to the type of tasks students were asked to assume. Some tasks could have been experienced as rather demanding (because of time pressure) although they were not very difficult. In such situations, interns would know exactly what to do and, thus, would not have an incentive to access their mentor. However, this interpretation is not supported by the data from this study and, therefore, requires further research. In summary, although the dimension of job demands was found to be related to some learning strategies, it was not identified as a general predictor of engineering student learning in internships.

Contrary to the expectations suggested by the JDCS model, job control was not found to be a positive or significant driver of interns' learning. Based on these findings, Hypothesis 2 must be fully rejected. Job control, therefore, seems to be an irrelevant factor for the design of internships in terms of engineering students' learning. It is worth observing that this result contradicts the majority of studies that indeed found job control to be one of the most important predictors of regular workers' engagement in active learning efforts (e.g., de Witte et al., 2007; Raemdonck et al., 2014; van Mierlo et al., 2001). An explanation for this finding might be the special role of engineering interns in work contexts (see also Beenen & Rousseau, 2010). They usually commence their internship with very little or no job-specific expertise that would actually allow them to make use of existing degrees of freedom at work. Without prior knowledge about different work tasks and problems or promising strategies to tackle unstructured and unclear situations, interns might easily feel overburdened. It follows that job control is not a workplace characteristic that is conducive to learning for interns.

Instead, it might be speculated that students need explicit guidance and instruction on what particular tasks and problems to focus on and what working strategies to use in given situations. Such guidance and instruction can be interpreted as the direct opposite of job control. The important role of external structure provided to interns by the employing organization has been emphasized by other studies (Beenen & Rousseau, 2010; Maertz et al., 2014; McHugh, 2017). However, whether guidance and instruction are conducive to the learning of engineering students cannot be answered by this study and remain subject to further research.

It is worth noting that job control was found to be a significant but negative predictor of students' use of external regulation activities. Thus, students utilized their mentors less often for learning in workplaces that are perceived to afford large degrees of freedom. In terms of the JDCS model, this finding seems to be fully counterintuitive, for reasons which are speculative only. One possible explanation is that students use external regulation especially in contexts where they work closely with their mentors. In such settings, interns might experience low job control but perceive only small barriers to asking their mentor in the case of questions and problems rather than trying to work out those issues for themselves.

Social support was found to be a highly relevant and significant predictor of external and shared regulation but not of the other learning activities. It was therefore not possible to confirm Hypothesis 3. The findings indicate that mentors and colleagues need to be perceived as available and accessible so that students consider them as relevant learning resources. However, perceived social support seems to be irrelevant for those learning activities that do not directly require other people (e.g., self-regulation). In hindsight, this is not surprising, since self-regulation, relating theory to practice, and the absence of avoidance strategies are not directly based on social interactions. In contrast, external regulation and shared regulation indeed require that interns have access to collegial guidance. At the same time, the strong observed relationships between social support and external regulation as well as shared regulation are remarkable, since previous studies could often find only small or even no effects of social support (e.g., de Lange et al., 2010; Gijbels et al., 2010; Raemdonck et al., 2014). Notwithstanding the finding that perceived social support significantly affected two of the five learning strategies, we have to reject the hypothesis that it is a general driver of interns' workplace learning as posited by the JDCS model.

All in all, the three JDCS dimensions together explained only between 15 and 31% of learning activities' variance, equaling small-to-medium-sized effects. The three dimensions best explained both external regulation and absence of avoidance. Self-regulation on the contrary was explained least well. This indicates that workplace characteristics are relevant for some kinds of learning activities only, while others are less strongly driven by them. Each learning activity was predicted by at least one of the JDCS dimensions, but none was related to all of them. Taken together, this answers Research question 2 and thereby provides rather poor evidence for the JDCS model. The overarching (extended) learning hypothesis stated by Karasek (1998) could therefore not be confirmed by this study and its particular research context.

From our perspective, at least three reasons for our findings partially contradicting both theoretical and empirical accounts can be offered: First of all, theories and empirical findings on regular workers' workplace learning might only be applicable to interns to a certain extent. Interns differ from regular workers in terms of their work experience, their long-term work perspective, as well as their role within the organization (see also Beenen & Rousseau, 2010). The JDCS model was not originally developed for interns, which might explain why job control in particular could not be found to be a relevant condition explaining interns' learning. The idiosyncrasies of interns in comparison with regular workers should be taken into account in theory building explaining interns' workplace learning. Second, Karasek (1979, 1998) described the concept of active learning only abstractly. Consequently, most prior studies have investigated active learning in a rather abstract way as a single construct. Such a procedure might have masked the ways in which different strategies to actively regulate learning at work in general, and during internships in particular, might be predicted by different job characteristics. In particular, the finding reported here that social support is only related to learning activities that actually make use of other people supports this interpretation. Although this study investigated the relationship between the JDCS model and student learning in a more refined way—by tapping into different types of student learning in internship contexts instead of operationalizing learning as a single construct—further research is needed to ascertain whether our findings can be replicated in other studies. Third, the JDCS model has been formulated as a general framework not specific to any work domain. However, work domains differ in terms of established rules and norms (Gelfand, Harrington, & Jackson, 2017; Lützén, Johansson, & Nordström, 2000). While asking for feedback or help might be considered an affront in one domain, it is highly encouraged in another. Thus, different domains might offer students' different settings for learning at work (see also Virtanen et al., 2014) and the findings reported here might reflect idiosyncrasies of internships in the engineering domain. To sum up, this study provided mixed findings about the key hypotheses central to the JDCS model. Although the model is claimed to be a general one for describing drivers for learning at the workplace, it does not provide straightforward answers on how to increase the quality of student learning during internships in engineering contexts.

6.2 | Limitations

This study, of course, also faces limitations and, thus, findings must be interpreted carefully. The most important limitations are as follows: First, only a relatively small convenience sample could be used for analysis, so it is not clear how robust or representative the findings are. In addition, because of the small sample, only main effects (i.e., direct relationships between the JDCS dimensions and the learning activities; see Section 4.3) and no interactions could be estimated. Second, the data were collected in a single particular university college of applied sciences in a European context. It follows that it is unknown how generalizable the findings are to other academic and cultural contexts. Third, all data were gathered using self-reports. On the one hand, self-reports can induce biased results, for instance, because of memory effects or tendencies to answer in a socially desirable way (Donaldson & Grant-Vallone, 2002). On the other hand, self-reports are useful for tapping into students' experiences and perceptions of regulation and learning and conditions at the workplace, all of which are important to address. Fourth, all information was measured retrospectively using a single questionnaire after the students finished their internships. In other words, all data came from a single data source and might, therefore, be affected by common method bias (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). Unfortunately, because of the small sample size, no common method bias test could be conducted. Fifth, all constructs were measured at the same time point. Strictly speaking, such a cross-sectional design does not allow testing for causality. The reported results give evidence only about empirical associations between variables. Such associations are, however, a prerequisite for causal relationships (Check & Schutt, 2012). Sixth, the JDCS dimensions were operationalized using a set of general items describing the internship. No detailed information about the work settings (e.g., difficulty of tasks instead of how demanding the work was experienced) of the students was investigated in this study. In particular, the JDCS dimensions might not have been constant during the internship. In this study, job demands, job control, and social support were measured as an abstract average over the whole internship. This could have canceled out existing effects of the JDCS dimensions. Seventh, although learning activities were measured in a multidimensional way, no information on the actual knowledge construction was obtained. Hence, it is unclear whether students actually developed their competence sets and how the JDCS dimensions mediated by the five learning activities contributed to such competence development.

6.3 | Suggestions for future research

Future research should try to replicate the findings reported here using methods that countervail the limitations. Above all, subsequent studies should collect larger samples from different cultural contexts to investigate both the robustness and the generalizability of the findings presented here. Larger samples have two important advantages: (a) they allow for estimation of regressions with interaction effects and thereby investigate Karasek's extended learning hypotheses more appropriately, and (b) they might open up the potential to differentiate between different engineering domains. For instance, workplace characteristics in chemical engineering or electromechanical engineering might foster or hinder learning differently. It would also be interesting to investigate whether the findings that do not support the JDCS model are indeed specific to the domain of engineering or whether they are more generalizable to other domains. In addition, future studies could employ more complex data collection designs including mixed methods (see Bazeley, 2017). Both workplace characteristics as well as learning strategies could be captured from different perspectives (e.g., student, supervisors) and at different time points during the internship (e.g., via a diary approach; see Rausch, 2014) as well as by different measurement methods (e.g., questionnaires and interviews). Such designs would allow collection of much richer insights that are not biased by common method variance and that would allow for causal interpretations of the data. Finally, future studies should also collect information on the learning outcome of students' internships (i.e., competence development). Doing do would then allow investigation of whether certain regulation strategies in relation to certain workplace characteristics might be most conducive to learning.

7 | CONCLUSIONS

This study used the JDCS model to explain engineering students' learning in internships. It thereby took a multidimensional perspective on learning to investigate a range of different practice-related learning activities (external regulation, shared regulation, self-regulation, relating theory to practice, and the absence of avoidance of learning). The empirical results provided mixed findings regarding the derived hypotheses, generating rather poor evidence supporting the JDCS model. Job demands, job control, and social support did not prove to be general predictors of engineering students' workplace learning during internships. Although some evidence was found that both perceived job demands and social support predict interns' learning, this result has to be interpreted quite carefully since both factors are related to some learning activities but not to all. Furthermore, our findings did not support the contention that more job control would be an important lever for engineering interns' learning in general. It follows that this study is not able to provide straightforward answers on how to increase quality of student learning during internships in engineering contexts and future research is needed.

ENDNOTE

[1] The Dutch items can be obtained upon request from the first author of this study.

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