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Robotizing Meaningful Work

Abstract

Purpose

Robots have a history of replacing human labor in undesirable, dirty, dull and dangerous tasks. With robots now emerging in academic and human-centered work, this paper investigates psychological implications of robotizing desirable and socially rewarding work.

Study design

Testing the holistic stress model, our study examines educational professionals' stress responses as mediators between robotization expectations and future optimism in life. The study uses survey data on 2,434 education professionals.

Findings

Respondents entertaining robotization expectations perceived their work to be less meaningful and reported more burnout symptoms than those with no robotization expectations. Future optimism about life was not affected by robotization expectations alone, but meaninglessness and burnout symptoms mediated the relation between expectations of robotization and future optimism.

Practical and social implications

Robotization may be viewed as challenging the meaningfulness of educational work by compromising ethical values and interaction. In order to prevent excess stress among personnel, robotization should be planned together with employees in co-operation negotiations. This implicates the need for co-designing technological changes in organizations especially in the cases of social use of robots.

Originality and value

Work's meaningfulness in robotization is a novel research topic and a step toward socially sustainable robotization.

Keywords

change management, meaningfulness, robotization, service robot, stress, technology, wellbeing, work

Robotizing Meaningful Work

For decades now, robots have been assigned *dirty, dull, or dangerous* tasks considered inconvenient and unpleasant for humans to do (Takayama *et al.*, 2008). However, as technology advances creating mobile, big data computing, machine learning and autonomous robots, also academic and human-centered service work becomes robotizable (Brynjolfsson and McAfee, 2014). This raises the question of the grounds for robotizing not only undesirable but now also desirable work: What are the consequences of delegating *pleasant, interesting, and inspiring* work to robots?

In this paper, we study whether the expected robotization of work is associated with an optimistic view of the future among educational professionals whose work is highly demanding but also categorized as pleasant, interesting, and socially rewarding (Watt and Richardson, 2007). Moreover, our aim is to better understand the mechanism through which expected robotization is linked to optimism about the future. For this we test two mediations, the positive path through meaningfulness of work and the negative path through burnout symptoms. Because this study focuses on the effects robotization may have in particular occupations and workplaces, it acts as a counterpart to the study fields concerning the ethical assessment of new innovations (Harris *et al.*, 2011). Instead of discussing the ethical design of robotics, this study focuses on the implementation stage of new technology.

Robotizing educational work makes a good example for the reason that it represents lines of work which have high expectations about bringing robots as assistants. Robots have already been piloted in educational use (Anwar *et al.*, 2019; Serholt, 2018) and these trials have received a considerable amount of attention both among professionals and in the media. However, social robots in particular are still perceived as curiosities rather than actual labor-saving tools in service and educational use (Ahtinen *et al.*, 2020; Reich-Stiebert and Eyssel, 2016). This timeframe of emerging

service robots and plans to implement social robots in education is optimal in order to investigate teachers' and school administrations' expectations of robotization, and how those expectations are linked to overall optimism about the future. It is also important to distinguish robots from other smart technologies. Technological systems and computer software have a higher probability to increase workers' autonomy at work while a robotic device entails always a risk of work changing to mechanistic (Volberda, 1996) and more routine-based in nature. In such case the working pace of everyone is connected to the working pace of a robot.

On the one hand, expectations regarding the use of educational robots are formed by the opportunities they offer in providing teaching assistance and supporting meaningful ways of job crafting, as well as democratizing education (Schiff, 2021; Smids *et al.*, 2019). In addition to gradual technological changes and the accompanying demands, school and teaching work has been facing increased requirements of cultural competence in a globalizing world (Keengwe, 2018). Davies and Heyward (2019) found that teachers experience considerable stress over whether they are spending too much or not enough time with children with learning difficulties. Robots open new ways of working by providing additional help with pupils with special needs, learning difficulties or foreign first languages. The option to assign some repetitive and remedial tasks to a robot, e.g., in learning the correct pronunciation of a new language, could reduce workload in competing demands when a teacher has a class with various types of students. This view is supported by a study where robots, not only assisted pupils with learning difficulties, but also increased motivation among socially deprived pupils (McNamara *et al.*, 1999).

On the other hand, there are negative expectations of robots replacing human labor and interaction while industrializing the line of educational work (Guilherme, 2019; Schiff, 2021; Smids *et al*., 2019). Robotization of work can be viewed as threatening people's jobs and careers (Danaher, 2017). Among school staff, it is mostly the administrative workers, not the teachers, who think that their work might even be supplanted by robots (Krutova *et al.,* 2021). Teachers may be adamant in

viewing robots as tools for teachers, not autonomous actors capable of independently taking over their tasks. Teaching is fundamentally human-centered work and teachers strive to maintain the ethical principles of respect, honesty, care, and fairness in their work, none of which can be expected of a robotic system (Campbell, 2000; Guilherme, 2019). Teachers are already suffering from ethical stress, for example, in competing demands between the wellbeing of students and the institutional rule base of the school (Shapira-Lishchinsky, 2011). Similar stressors may arise in introducing robots in educational use. Teachers have reported robot use to be a possible threat to students' privacy and emotions (Serholt *et al.,* 2016). Teachers of younger children in particular may be wary of using robots in a teaching role because of the distinct trust between teachers and their students. Children trust their teachers for the psychological agency the teachers represent; that is, the ability to think, make decisions, and interact in an effortless manner (Brink and Wellman, 2019). This psychological agency is lacking in machines even in a scenario where it would be flawlessly simulated by an artificially intelligent social robot. Teachers may find the role of a robot ambiguous regarding whether it is supposed to be an instrument or a social entity (Serholt *et al.,* 2016). Is it even possible to maintain a sense of the meaningfulness of work if it is framed as something a robot could do, or does that rather add to cynicism about one's work?

The rationale for studying robotization of meaningful work is the paradox where robots, by definition, are intended to assist people but in some cases robotization is actually planned to take over tasks that people find interesting and inspiring and would prefer to do themselves. This study examines expectations of robotization and future optimism in a correlative study design where stress responses (positive and negative) are viewed as mediators in the relation between robotization expectations at work and optimism about the future in life. Following the holistic stress model by Nelson and Simmons (2003; Simmons and Nelson, 2007), demands at work are understood to cause people both positive (eustress) and negative stress responses (distress). Positive responses include, for example, the way demanding work is perceived simultaneously as meaningful – and in a positive

circle, because of the feeling of meaningfulness, it is also easier to endure the high demands (Nelson and Simmons, 2003). The negative stress responses refer to employees' experiences of work demands as excessive, draining, and frustrating, causing exhaustion and cynicism as symptoms of burnout (Schaufel and Taris, 2005).

Background

Expectations Regarding Emerging Service Robotization

Forming expectations of robotization, people depend on their direct, indirect, and vicarious (Kellert, 2002) experiences of robots. Here, indirect experiences involve attending, for example, an organized robot showcasing or workshop where the attendee's role is to spectate but not to participate hands-on in trying out the robot, while vicarious experiences refer to even more remotely gained information from the media, the press, internet, and television. Media exposure has an important role in forming views about robots and emerging robotization in an age where robots are still a rare sight in service sector work (Lee and Šabanović, 2014; Righetti and Carradore, 2019, p. 450). In a time when intelligent robots are only just emerging to service work, people evaluate the usefulness of this new technology, not only by their experiences but also using their counterfactual imagination (Seibt, 2021). Prior studies show that employees' awareness of the impact of smart technology, artificial intelligence, robotics and algorithm developments is negatively associated with organizational commitment and career satisfaction, and positively related to turnover intentions, cynicism, and depression (Brougham and Haar, 2018, p. 239).

Direct experiences, then, refer to firsthand knowledge about using robots. While certain teachers in vocational education in the industrial and technical disciplines already have some experience of working and teaching with robots, robotics remains a novelty when it comes to elementary and high school education. In other words, some vocational education involves robots because of their intrinsic value, where the robot is an object of learning in itself (Van de Poel, 2011, p. 73) for the robotized industry the education is preparing its students for (e.g., assembly, machining,

welding). However, robots can also have instrumental value in teaching, or rather, in assisting in the guidance of students. These teachers' assistant robots can be categorized as telepresence and social robots.

Telepresence robots (e.g., "Double") are mobile teleconference devices which are operated and maneuvered from a remote location. Telepresence robots are merely a medium in human-human interaction, whereas with social robots we are talking about human-robot interaction. Social robots are defined as reprogrammable machines designed to communicate and interact with people according to an assigned role (Bartneck and Forlizzi, 2004). Social robot pilots in schools resemble the social robot trials in care or customer service work where the robot is assisting in a certain, very limited task. Ahtinen's group, (2020) studied a robot-doll-like talking and walking robot "NAO" that was teaching foreign languages to 9 to10-year-olds. The teachers in the sample underlined the need for support and standards if robots were to become a routine part of teaching (Ahtinen *et al.*, 2020). "NAO" was also used as an example in a survey study on teachers' attitudes to education robots utilized as assistants to teachers and for helping with the preparation of lessons. The average attitudes were on the negative side and the teachers were concerned that the robots would increase workload and replace human-human interaction (Reich-Stiebert and Eyssel, 2016). In another study, a social robot "EMAR" had more of a companion than a teaching role. Some of the high school students, as the participants of the study, sometimes found it easier to talk to the robot instead of a teacher (Björling *et al*., 2019). Despite the promising result of successful human-robot interaction in that case, this topic is deemed ethically challenging. Sharkey (2016) points out ethical concerns such as attachment, privacy, and deception when it comes to robot use and this is particularly relevant in situations where a robot simulates emotion, partnership, and understanding.

Positive and Negative Stress Responses Predicting Future Optimism

Optimism about the future refers to generally expecting positive things from the future and believing that any present distress is likely to turn out for the better (Carver and Scheier, 2014; Chang *et al.*,

2013). Thus, optimism about the future is understood as a gradually accumulating cognitive construct rather than situational positive thoughts. There is some evidence about how expected technological changes affect the optimism about the future, for example, how technology-oriented young professionals are less prone to waver in their trust in a promising future than are young professionals in the people-oriented (e.g., education) fields of work (Roseel, 1985; 1989). In this study of education professionals, robotization – as a form of a technological change – is considered a stressor. Deriving from the holistic stress model, the stressor is viewed as arousing potentially both positive and negative responses (Nelson and Simmons, 2003; Simmons and Nelson, 2007). According to Simmons and Nelson (2007), the same stressor may elicit both positive responses and negative responses in one and the same individual. Employees who expect that their work will be robotized may experience positive stress (e.g., meaningfulness of work) and negative stress (e.g., mental fatigue) simultaneously.

The negative stress responses are still emphasized in the work stress literature over the positive stress responses (Aloe *et al.*, 2014). Negative stress responses include, for example, the most pivotal symptoms of burnout: exhaustion and cynicism (Schaufeli and Taris, 2005). Exhaustion refers to the employee's subjective experience that work-related demands exceed and deplete their physical and mental reserves (Maslach and Leiter, 2016; Maslach *et al.*, 2001). Thus, exhaustion is likely where time and other resources and individual resources do not match the demands of the work. Preparing for work-related changes may also test an employee's personal reserves and employers should carefully determine the staff's need for resources, e.g., equipment and education, already when the changes are being planned (Knani, 2013). Stress is a subjective experience and different stressors affect some individuals more than others. While female gender in some studies correlates with more severe exhaustion (Lackritz, 2004), a review of teachers' burnout symptoms found no strong evidence of this (Watts and Robertson, 2011). More convincing evidence is found as regards age, showing that

younger teachers are more susceptible to emotional exhaustion than older ones (Byrne, 1991; Lackritz, 2004; Watts and Robertson, 2011).

Cynicism as another negative stress response is defined as mental distancing from the job. This manifests in withdrawal and negative attitudes toward work as well as things and people associated with it (Maslach and Leiter, 2016; Salanova *et al.*, 2005). Technological changes emerging at the workplace without questions or an honest opportunity for the staff to participate in the planning phase entail a real potential to cause cynicism in employees (Gilmore, 2003, p. 203). Robots can be viewed as changing the values of work and de-humanizing the work, even the part still done by people (Taskin *et al.*, 2019). Moreover, robotization may cause additional distress in the form of fear of technological unemployment. The threat of unemployment caused by technology has been implied to manifest in impaired psychological wellbeing and sense of self-worth (Granulo *et al.*, 2019; Reichert and Tauchmann, 2011). Indeed, in addition to constituting a threat to personal income and career, technological unemployment causes distress about the overall future and role in life (Danaher, 2017).

The tradition of positive psychology and more holistic views on stress have brought to light the positive stress responses (Simmons and Nelson, 2007). One of the positive stress responses is the perceived meaningfulness of work, reflecting a subjective perception of the significance of work and its compatibility with the purpose of one's existence and life goals (Lips-Wiersma and Morris, 2009; Lysova *et al.*, 2019). As a positive stress response, meaningfulness of work refers to situations where demanding work is perceived as rewarding, significant, and worth all the effort and commitment (Nelson and Simmons, 2003; Steger *et al.*, 2012). Meaningfulness can be seen as promoting optimistic views about the future even in stressful situations (Seligman *et al.*, 2006). Thus, robotization may be viewed as something that will require a significant amount of learning and reorganizing, but at the same time, as a change that will be worth all the effort and support work's meaningfulness.

Earlier research findings show that higher meaningfulness predicts job satisfaction (Allan *et al.,* 2018; Hu and Hirsh, 2017; Liden *et al.,* 2000) as well as general wellbeing in life (Steger and Duffy, 2012). According to a recent review, for work to be considered meaningful, it requires sufficient autonomy and opportunities for job crafting (Lysova *et al.,* 2019). Robotization can support autonomy and job crafting, for example, by increasing the range of teaching methods. However, robotization can also decrease autonomy and job crafting if the robots are brought into the organization "top down" with an expectation of mandatory robot use. Because of the possible impact on wellbeing, the developing and implementing intelligent systems to education sector should be done more often in co-operation with teachers, administrators and education researchers (Schiff, 2021).

Regarding emerging robotization, no research has so far been presented on how the perceived meaningfulness of work and negative stress symptoms are affected by expectations of one's own line of work being robotized. First, we ask how the expected robotization is associated with feelings of the perceived meaningfulness of one's work and the burnout symptoms of cynicism and exhaustion. Second, we ask how the positive stress response of meaningfulness and the negative stress responses of burnout symptoms explain the relation between expectation of robotization and overall optimism about life in the future.

Conceptual Framework and Hypotheses

In developing our conceptual model, as shown in Figure 1, we adapted the model of positive and negative stress (Nelson and Simmons, 2003; Simmons and Nelson, 2007). Along with the implications that technological changes have the capacity to affect the optimism about the future (Danaher, 2017; Roseel, 1985; 1989), positive and negative stress are known predictors for overall psychological wellbeing (Simmons and Nelson, 2007; Steger and Duffy, 2012).

[FIGURE 1 ABOUT HERE]

The first assumption was that because technological reforms have the potential to increase the perceived meaningfulness of educational work (McNamara *et al.,* 1999; Smids *et al.,* 2019), the expected robotization affects optimism about the future through a positive path of work's meaningfulness.

> H1: Robotization expectations interrelated with a higher level of perceived work's meaningfulness result in higher optimism about the future.

The second assumption was that because technological changes have been found a possible cause for negative stress (Gilmore, 2003; Smids *et al.,* 2019), the expected robotization affects optimism about the future through a negative path of burnout symptoms.

> H2: Robotization expectations interrelated with burnout symptoms result in lower optimism about the future.

Method

Data Collection

This study is a part of a larger research project examining mental work demands and employee well-being in different occupational groups in Finland. Survey data was collected for the project in 2018. The survey was completed online, optimized for both computers and mobile devices and piloted before data collection. Participation was voluntary and the data was anonymized as a part of the ethical procedure.

The study uses a sample of 2,434 (response rate 48%) currently working education professionals, members of the Trade Union of Education (OAJ). The participants were recruited via the trade union as of all Finnish teachers 95% belonged to the trade union in 2015 (OAJ, 2015). The final sample consisted of those 1,687 respondents who had no missing values in all study and control variables. Of these 94% were teachers and 6% administrative workers, 12.3% worked in managerial positions, and 79% were female (M_{age} = 49.4, SD = 10.8). Of the respondents, 15.6% worked in pre-

primary education (for children up to seven years old), 37% in comprehensive schools (for 7–16-years-olds), 13.5% in upper secondary schools, 15.9% in vocational institutions, 13.4% in other educational institutions (e.g., universities and adult education centers). The level of education was high among the respondents: 3.7% had university postgraduate degrees, 68.2% a master's degree from a university, and 20.4% had a master's degree from a university of applied sciences or a bachelor's degree from a university.

Measures

Optimism about the future was measured with a single item adapted from the flourishing scale (Diener *et al.,* 2010). The statement 'I am optimistic about my future' was used to indicate psychological, future-oriented wellbeing reflected on one's life in general, not just in the context of work. The statement was rated on a scale from 1 (= *totally disagree*) to 7 (= *totally agree*). The variable was skewed (skewness = -1.03, kurtosis = 1.39; see mean at Table 1) and 62.4% of respondents reported having high optimism for the future (rating of 6 or 7). Descriptive information of all the measures and alpha coefficients is presented in Table 1.

[TABLE 1 ABOUT HERE]

Robotization expectations were measured with two items: 'In the future, robots or automation can replace work tasks in my industry' and 'My current job can be automatized or replaced by robots in the future' on a scale from 1 (= *totally disagree*) to 5 (= *totally agree*). The aggregate variable for the two items (scale 1–5) had adequate internal reliability (α = .76) but was badly skewed (skewness = 1.95, kurtosis = 3.94) and most of the respondents (58.6%) had the lowest expectations regarding robotization. Thus, the aggregate variable was dichotomized by using its mean (M = 1.46, SD = 0.73) as a cutting point (1 through 1.5 = 0; 1.6 through 5 = 1).

Meaningful work was measured using the Work and Meaning Inventory (WAMI; Steger *et al.,* 2012) and its sub-scale of positive meaning of work on a scale from 1 (= *totally disagree*) to 7 (= *totally agree*). This sub-scale includes four items (e.g., "I have discovered work that has a satisfying purpose"). An aggregate mean variable was computed and equalized after which higher scores reflected higher level of perceived meaningfulness of work.

Burnout symptoms were assessed using sub-scales of emotional exhaustion (three items) and cynicism (three items) from the Bergen Burnout Indicator-9, the reliability and validity of which have been confirmed before in Finnish samples (Salmela-Aro *et al.,* 2011; Feldt *et al.,* 2014). Answers were given on a 6-point Likert scale (1 = *totally disagree*, 6 = *totally agree*). An aggregate mean variable was computed with higher scores indicating higher level of symptoms.

Control variables gender, age, partnership (living with a life partner or not), and managerial position (yes/no) were included in the analyses. By doing so, we were able to ascertain whether robotization expectations explained variance in work stress beyond the classic indicators of age and gender (Byrne, 1991; Lackritz, 2004) and make sure that, beyond social living situation, work-related demands also account for the variance in overall future optimism (Álvaro and Garrido, 2003, p. 184; Ward *et al.,* 2007). It was important to control for age, gender, and managerial status because prior studies have shown them to consistently correlate with attitudes toward service work robotization and expectations of technological unemployment (Turja *et al*., 2018).

Data Analysis

Data was analyzed using the IBM SPSS program (version 26). As an analytic strategy, we first assessed whether there were any baseline differences between the two groups in terms of robotization expectations. Comparisons between groups were tested with the Mann–Whitney U tests as the variables were not normally distributed. The explorative results are reported in percentages, correlations, means (*M*), standard deviations (*SD*), and medians (*Mdn*).

Subsequently, to test our primary hypotheses, a mediation model was run using the PROCESS macro for SPSS (version 3.3) (Hayes, 2018) using bootstrapped confidence intervals which also enables a reliable analysis when variables are skewed as was the case with all the variables studied. The mediation model included control variables (gender, age, partnership, and managerial position) and is reported by standardized coefficients, statistical significance, and the predictive power of the model (R^2).

Results

As exploratory analyses we ran correlations (Spearman) and compared study variables between the respondents who had robotization expectations and those who had not. The respondents with robotization expectations were less optimistic about the future than those who did not expect robotization or automatization to take over work in their job or industry (M = 5.48, Mdn = 6.00 vs. M = 5.69, Mdn = 6.00; U = 240405.00, $p < .01$). Also, those with robotization expectations perceived their work to be less meaningful than did those who had no such expectations (M = 5.65, Mdn = 5.75 vs. M = 5.93, Mdn = 6.00; U = 219306.50, $p < .001$). Moreover, the respondents with robotization expectations reported more burnout symptoms than those with no such expectations (M = 3.12, Mdn = 3.00 vs. M = 2.99, Mdn = 2.83; U = 244914.50, $p < .05$). Three moderate correlations between the study variables were found: a positive correlation between optimism about the future and meaningfulness of work (r_s = .50; $p < .001$), a negative correlation between optimism about the future and burnout symptoms (r_s = -.44; $p < .001$), and a negative correlation between meaningful work and burnout symptoms (r_s = -.51, $p < .001$).

[FIGURE 2 ABOUT HERE]

A mediation model was run in order to test the hypotheses concerning the intervening factors between robotization expectations and optimism regarding the future. The bootstrap results are presented in Figure 2, which shows a full double mediation. That is, robotization expectations were associated with optimism regarding the future only indirectly via perceived meaningfulness of work and burnout symptoms. The total effect of robotization expectations on future optimism was negative (b = -.20, SE = .06, p < .01), meaning that those with expectations regarding robotization reported less optimism regarding the future. Indirect effects of robotization expectations on optimism regarding the future via meaningful work and burnout symptoms were also negative (b = -.15, SE = .04, p < .01). The indirect effect via meaningful work was slightly greater than the indirect effect via burnout symptoms. Of the total association between robotization expectations and optimism regarding the future, 55.9% was transmitted via meaningful work, 20% via burnout symptoms, and 24.1% directly. The mediation model explained 31% of the variance in optimism about the future.

Discussion

In an era where robots are just starting to emerge in the service and social sectors of work, this study examined how robotization expectations among education professionals associate with positive stress (meaningfulness of work), negative stress (burnout symptoms), and overall optimism about the future. It was analyzed how the positive stress response of meaningfulness and the negative stress responses of symptomatic burnout mediated the relation between the robotization expectations and overall future optimism about life.

The explorative results already suggested that robotization expectations are more likely to have a negative association with education professionals' psychological wellbeing in the form of burnout symptoms, less sense of the meaningfulness of work and less optimism about the future. Education professionals who felt that their job or field of work might be robotized in the future reported more burnout symptoms, and less meaningfulness of work on the average. Robotization

expectations were thus associated with negative stress responses but not with positive ones. In other words, the professionals who thought that their line of work might undergo major technological changes were prone to report more burnout symptoms and lower meaningfulness of work. One interpretation is that robotization expectations entail more perceived threats than promises of a positive reform of educational work. Although robotization has possibilities in supporting the pleasantness and meaningfulness of educational work (McNamara *et al.,* 1999), it may mostly raise cynicism and appear as a double threat of replacing jobs and compromising the ethical values and interaction crucial in the human-centered field of work (Guilherme, 2019; Reich-Stiebert and Eyssel, 2016; Sharkey, 2016). Following Schiff's (2021) theorization, educational professionals fall more into the to the category of sceptics than proponents of assistive robots.

In the stress model of Simmons and Nelson (2007), positive and negative stressors are seen as separate factors which may exist concurrently, for example, a person may feel exhausted at her job but at the same time feel she is contributing to something meaningful. Our study did not support the co-occurrence of positive and negative stressors but rather the opposite as expecting robotization was associated with *less* meaningful work and *more* burnout symptoms. Also, the respondents with high perception of the meaningfulness of their work had lower burnout symptoms on average. Thus, higher positive stress correlated with lower negative stress. The results can be viewed as corroborating those findings where lower work engagement causes exhaustion and cynicism (e.g., Demerouti *et al.,* 2010) or where perceived meaningfulness of work supports positive feelings about work (Allan *et al.,* 2018; Hu and Hirsh, 2017; Liden *et al*., 2000).

Acknowledging the possible reverse causality in our study design, the other way to look at these results is to interpret that those who feel their work is meaningless have high hopes for robotization and those who find their work meaningful do not see many possibilities for robots to replace their human labor. Again, taking account of the possibility of reverse causality, some respondents may suffer from burnout symptoms and therefore have high expectations for robotization

as something that would have a positive impact on the demands of work. The educational professionals who reported feelings of work-related fatigue and cynicism had higher expectations for a renewal of work with robotic assistance. That is to say, these individuals may find relief from thinking that new technology will make their work less burdensome – perhaps less hectic and morally conflicting when it comes to increased and competing demands in the classroom (Davies and Heyward, 2019; Shapira-Lishchinsky, 2011).

However, regardless of the causality between the explanatory factors, the mechanisms found in this study show a constant negative link between robotization expectations and wellbeing at work, which has a further role in overall optimism about the future. The discovery regarding our second research question was that the connection between robotization expectations and general optimism about the future has two paths: through perceived meaninglessness of work and through burnout symptoms. Thus, we conclude that optimism about the future is not affected by the mere expectation of the emergence of educational robots. Only if it reaches the point where the meaningfulness of work is at risk will it become an issue. In the same vein, optimism about the future is not susceptible to mere expectations of robotization, but if one has simultaneously a higher risk of burnout, it is more probable that the individual will not be able to maintain optimism in life. We interpret these findings also as a matter of accumulation. If an individual feels her work is meaningless, burdening, and frustrating, it makes it harder for her to view life as full of promises and fulfillment – especially after hearing about plans to robotize her work (cf. Danaher, 2017).

On the contrary to our hypothesis (H1), robotization expectations interrelating with perceived work's meaninglessness associated with more optimistic views of the future. The second hypothesis (H2) was supported, since robotization expectations interrelated with burnout symptoms which, again, resulted in lower optimism about the future. This finding provides additional evidence on how emerging technological changes can be a cause for negative stress (Gilmore, 2003; Smids *et al.*, 2019) and how this can furthermore have a negative effect on overall wellbeing (Simmons and Nelson,

2007). In this part, the current study repeated the assumptions based on prior research, now applied specifically for robotization.

The link from work's perceived meaningfulness to optimism about the future proved to be the most significant association in the multivariate analysis. The result leaves room for two opposite interpretations and mechanisms: robotization either withholds a promise of renewing work to a more positive direction for those who are losing the feeling of work's meaningfulness (Smids *et al.,* 2019), or robotization in this field of work seems absurd for those who perceive their work as highly meaningful. For example, teaching work has much to do with authentic, deep interaction and the ethical principles of respect, honesty, care, and fairness – difficult or impossible to imitate by any machines (Brink and Wellman, 2019; Campbell, 2000; Guilherme, 2019; Reich-Stiebert and Eyssel, 2016; Sharkey, 2016).

Indeed, robotization may be viewed as challenging the meaningfulness of educational work and being a threat not only to personal employment, but also to ethical values and human-human (vs. human-robot) interaction that is still today very much at the core of teaching work (Brink and Wellman, 2019; Guilherme, 2019; Reich-Stiebert and Eyssel, 2016; Sharkey, 2016). Also, if the personal-level prerequisites for meaningful work are sufficient autonomy and opportunities for job crafting (Lysova *et al.*, 2019), the question is, how are they supported in a situation where robots replace teachers e.g., in practicing a foreign language? Generally speaking, robots do have, in certain situations, the ability to enhance human workers' autonomy, agency, and opportunities for job crafting (Smids *et al.*, 2019). Robots may increase teachers' autonomy to arrange everyday teaching according to their preferences, but one important aspect to consider is the maturity of technology. Social robots are not autonomous or multifunctional, and at this stage of technological development they are more likely to take time from professionals instead of saving resources (Van Aerschot and Parviainen, 2020). Taking an example from a care context, social robots have been used in giving

exercise instructions to residents in geriatric care homes, but the nursing staff described using the robot as laborious and time consuming (Melkas *et al.*, 2016).

It is important to provide different occupational fields with current information about the attributes robots have in reality, as well as the realistic scope and magnitude of emerging robotization (cf. Van Aerschot and Parviainen, 2020). Unfounded or exaggerated perceptions of being replaced by new technology cause less optimism about the future among those who find their work meaningful. There are signs of a phenomenon where people evaluate the risk of robotization higher than it actually is (Walsh, 2018) and this is due specifically to the media hype around new technologies and artificial intelligence (Naudé, 2019). New technology has a long tradition of raising moral panic (Hampton and Wellman, 2018). In this case moral panic would refer to a fear of diminished human-human interaction in the human-centered jobs which robots would take over, although the robot's social and multifunctional capabilities will not be a reality even in the near future. To prevent unnecessary cynicism during robotization plans, we encourage early workplace discussions, for example in the form of interventions among different levels of employee groups in order to inform the staff correctly about the technological change and offer them an opportunity to share their insights about the plans and support the collective beliefs in self-efficacy (cf. Simbula and Guglielmi, 2010).

Mindful of the limitations of cross-sectional studies, we acknowledge that drawing conclusions regarding causality is not possible and therefore longitudinal designs are needed to confirm our findings. Particularly, the reverse causality assumptions should be studied in the future via full-panel designs. Also, the findings remain at an indicative level when it comes to other fields of service or academic work, as well as educational work in other cultures. The generalization of the results is limited to education professionals in Finland and we recommend parallel context studies in order to verify them. At the same time, one of the strengths of this study is the high response rate and representativeness of the data when compared to the population of Finnish teachers. Furthermore,

education professionals were a relevant target group for this study because teaching is perceived to be one of the most meaningful jobs as well as one of the most stressful occupations (Richards, 2012).

Conclusions

Robots are being gradually introduced to the new lines of work. Those education professionals who expect robotization in their field of work to be realized, are the ones with more burnout symptoms and a lowered feeling of work's meaningfulness on the average. Respectively, those who think robotization is not going to affect the education sector, report lower level of burnout symptoms and perceive their work as relatively meaningful. Robotization expectations together with work-related burnout symptoms and lowered meaningfulness are associated with overall optimism about the future. Thus, robotization expectations can be a cause for negative stress which has a further negative effect on overall wellbeing. In order to maintain employee motivation during a technological change, there is a need for an open and genuine consultation with the staff. This is evident especially when planning the robotization of pleasant, interesting, and inspiring work. Different level employees should be invited in planning and co-designing workplace robotization. Technological changes in general are advisable to include in the co-operation negotiations. Sharing facts to the employees at early stage is an act of social responsibility and a way for the change management to act as a counter force to the exaggerated imaginaries of robotization presented for example in the media.

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Tables

	1.	2.	3.	4.	5.	6.	7.	8.
1. Future optimism	-							
2. Meaningful work	.50***							
3. Burnout symptoms	-.44***	-.51***						
4. Robotization expectations[a]	-.08**	-.13***	.05*					
5. Gender[b]	-.04	-.11***	-.06*	.13***				
6. Age	-.00	.02	.01	.07**	.00			
7. Partnership[c]	.06*	.01	.03	.01	.03	.01		
8. Managerial position[d]	.11***	.08**	-.05*	.01	.01	.09***	.01	
M / %	5.64	5.86	3.02	24.8	79.0	49.42	81.4	12.3
SD	1.13	0.94	1.05	-	-	10.74	-	-
α	-	.88	.85	-	-		-	-

Note. The row *M / %* shows percentages of [a]robotization expectations, [b]male participants, [c]living in partnership, [d]managerial position
* p < .05, ** p < .01, *** p < .001

Table 1. Descriptives and Spearman's correlations between the study variables

Figures

Figure 1. Proposed research model

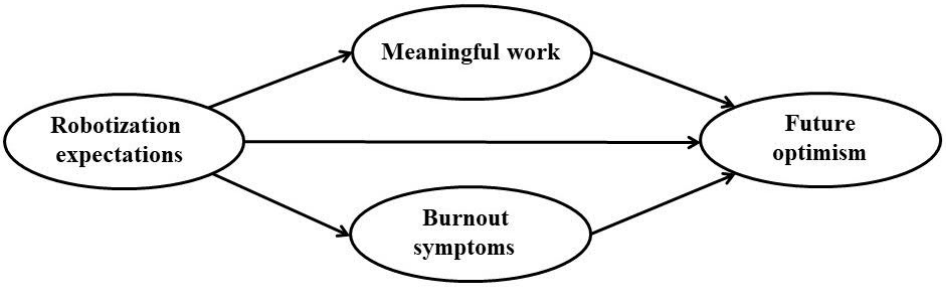
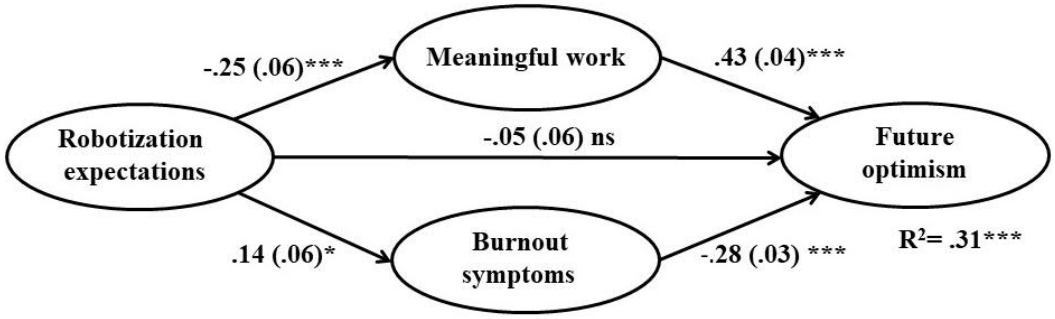


Figure 2. Bootstrap results for regression model parameters



Note: The estimates are adjusted for the effects of control variables (gender, age, partnership, and managerial position).