MOOD: Mindfulness fOr sOftware Developers

Simone Romano
Department of Computer Science, University of Salerno
Italy
siromano@unisa.it

Giuseppe Scanniello
Department of Computer Science, University of Salerno
Italy
gscanniello@unisa.it

Alessandro Marchetto
Department of Information Engineering and Computer Science, University of Trento
Italy
alessandro.marchetto@unitn.it

Paolo Giorgini
Departmnet of Information Engineering and Computer Science, University of Trento
Italy
paolo.giorgini@unitn.it

Gloria Guidetti
Department of Psychology, University of Turin
Italy
gloria.guidetti@unito.it

Daniela Converso
Department of Psychology, University of Turin
Italy
daniela.converso@unito.it

Sara Viotti
Department of Psychology, University of Turin
Italy
sara.viotti@unito.it

Abstract

Peopleware, which includes anything related to the role of people in Software Development (SD), has been arousing an increasing interest from both the software industry and research community. This interest is due to the current economic system that demands high-quality software products with a short time to market, staying on the budget. This exposes software developers to the risk of experiencing stress, burnout, and reduced motivation, leading, in turn, to reduced job performance, low-quality SD-related artifacts, and increased turnover. *Mindfulness* represents a promising intervention that might let developers do their best at work, limiting or even preventing the previously mentioned negative outcomes. This paper presents *MOOD* (*Mindfulness fOr sOftware Developers*), a research project whose overarching goal is to customize a well-known and validated group-based intervention program, *Mindfulness-Based Stress Reduction* (*MBSR*), in the context of SD-related tasks and assess whether it helps developers to improve their well-being and performance, as well as the quality of the SD-related artifacts they produce.

Keywords

Peopleware, Mindfulness, Mindfulness-Based Stress Reduction, MBSR

ESEM '24, October 24–25, 2024, Barcelona, Spain

ACM ISBN 979-8-4007-1047-6/24/10
https://doi.org/10.1145/3674805.3695392

ACM Reference Format:
Simone Romano, Giuseppe Scanniello, Alessandro Marchetto, Paolo Giorgini, Gloria Guidetti, Daniela Converso, and Sara Viotti. 2024. MOOD: Mindfulness fOr sOftware Developers. In *Proceedings of the 18th ACM / IEEE International Symposium on Empirical Software Engineering and Measurement (ESEM '24), October 24–25, 2024, Barcelona, Spain.* ACM, New York, NY, USA, 4 pages. https://doi.org/10.1145/3674805.3695392

1 Motivation and Research Context

The software industry is human-capital intensive. The competitive advantage of software companies and the quality of the software products they develop depend on their capability of acquiring and retaining talented software developers. To that end, software companies should invest in promoting engagement and motivation toward the job [1]. High-tech companies, such as *Google* or *Meta*, are famous for valuing *peopleware*, which includes anything related to the role of people in Software Development (SD) [4]. Indeed, these companies are known for the perks offered to their employees such as having fun things to do or good food to eat at workplaces during working hours [8]. Peopleware has been arousing an increasing interest from the Software Engineering research community as well. For instance, work on peopleware has studied the impact of sleep deprivation on software developers [6], the role of their moods/emotions and personality traits [8, 18], the effect of noisy workplaces [19] in SD, and much more. The interest in peopleware is due to the current economic system that demands high-quality software products with a short time to market, staying on the budget. This exposes software developers to the risk of experiencing stress, burnout, and reduced motivation, leading, in turn, to reduced job performance, low-quality SD-related artifacts, and increased turnover [3, 15]. In such a context, the literature on peopleware has highlighted that, to limit or even prevent these negative outcomes, it is paramount to act on extrinsic aspects of the job (*e.g.*, fun workplaces) but also on intrinsic aspects that might affect SD [8].

Among the intrinsic aspects, *mindfulness* represents a promising intervention to let developers do their best at work, limiting or even preventing the previously mentioned negative outcomes. This is because mindfulness helps improve well-being [20] and is thought to enhance people's ability to focus on the task at hand and let people be less distractible to extraneous stimuli and avoid mistakes [7]. Mindfulness originated in Buddhism and became prominent in the West through Kabat-Zinn [11]. High-tech companies have been showing interest in mindfulness. For instance, Chade-Meng, when he was an engineer at Google, developed a mindfulness course to help employees manage stress at work. His course has today a six-month waiting list and has been taken by more than 1,500 employees since 2007. Despite the promising impact of mindfulness on employees' well-being and the great interest of high-tech companies, mindfulness protocols have been employed in work settings without sound evidence of their effects on employees' productivity and work-related outcomes [9]. Among the mindfulness protocols available in the literature, *Mindfulness-Based Stress Reduction* (*MBSR*) [11] is a manualized and validated group-based intervention program focused on training the self-regulation of attention and awareness, thereby enhancing voluntary control of mental processes. MBSR consists of eight 2.5-hour weekly sessions, home assignments, and a full day on retreat in the second half of the program. The sessions consist of training and practice in mindfulness meditation, informational presentations on topics like stress physiology, and group discussions. Empirical evidence on the effectiveness of MBSR has shown that it helps improve employees' well-being in different working contexts [14, 20], but not in SD.

This paper presents *MOOD* (*Mindfulness fOr sOftware Developers*), a research project whose overarching goal is to tailor MBSR to software developers and provide empirical evidence on the effectiveness of the tailored MBSR protocol in improving developers' well-being (*e.g.,* reducing stress) and performance, as well as the quality of the SD-related artifacts that developers produce. MOOD is funded by the *Italian Ministry for Universities and Research* (*MUR*) through the *Research Projects of Significant National Interest* (*PRIN*) program (some information on MOOD is summarized in Table 1).

To evaluate the effectiveness of the tailored MBSR protocol, we planned to use both objective and subjective measures. The combined use of objective and subjective measures of performance and well-being is quite rare in the literature and this should ensure the conclusions of our project are grounded on stronger evidence. Another novel aspect of MOOD is the inclusion of subjective measures concerning the mindfulness trait, psychological capital, and personality traits, which should allow us to test the mediating and moderating roles of these factors. This might help advance scientific knowledge by shedding light on the role of these factors in the underlying mechanisms by which the MBSR protocol might lead to an improvement, over time, of developers' performance and well-being, and quality of SD-related artifacts. Finally, we would like to note that the participants in the MOOD project are from two different communities: Software Engineering (*i.e.,* the authors from the Universities of Salerno and Trento) and Work and Organizational Psychology (*i.e.,* the authors from the University of Turin). Although work on peopleware borrows frameworks and instruments from the Psychology research field, collaborations between computer scientists and psychologists are quite rare.

Table 1: Some information on MOOD.

Name:	Mindfulness fOr sOftware Developers (MOOD)
Website:	https://sites.google.com/unisa.it/moodproject/home-page
Duration:	24-months (from September 28th, 2023)
Funding Agency:	Italian Ministry of the University and Research (MUR)
Participants:	Universities of Salerno, Turin, and Trento
Presenters:	Simone Romano, Sara Viotti, and Alessandro Marchetto
Status:	Ongoing

2 State of the Art

While studies have provided empirical evidence on the effectiveness of the MBSR protocol in improving well-being in different working populations [14, 20], only the study by Bernárdez *et al.* [3] has suggested that practicing mindfulness (not the MBSR protocol, specifically) might help increasing performance in a task related to SD (conceptual modeling, specifically). In this respect, we would like to remark that empirical evidence needs to be gathered to show that results achieved in other working populations, or by considering other SD-related tasks, also hold in the population of software developers, or by considering different SD-related tasks. In other words, MOOD will expand the body of knowledge on the (short- and long-term) effects of mindfulness in the SD context since we aim to achieve a deep understanding of the impact of the ad-hoc MBSR protocol on developers' well-being and performance, and quality of SD-related artifacts. Finally, although MOOD is forced to last at most two years, we aim to delineate lessons learned that can drive the research for the following years.

3 Objectives and Methodologies

The overarching goal of MOOD, formulated according to the *Goal-Question-Metric* template [2], is:

> **Assess** an MBSR protocol tailored to software developers **for the purpose of** evaluating its effects and retention **with respect to** developers' well-being and performance, and quality of SD-related artifacts **from the point of view of** researchers and software professionals **in the context of** SD-related tasks.

In line with the goal mentioned above, MOOD aims to achieve the following objectives:

O1. Tailoring MBSR to software developers to let them get the best from mindfulness when carrying out SD-related tasks.
O2. Assessing whether the ad-hoc MBSR protocol has positive effects, in the context of tasks related to SD, on different constructs, namely: developers' performance and well-being, and quality of SD-related artifacts.
O3. Assessing how long software developers retain the effects of the ad-hoc MBSR protocol on developers' performance, well-being, and quality of SD-related artifacts.
O4. Distilling the lessons learned.
O5. Disseminating the gained knowledge among researchers and software professionals (*e.g.,* developers, project managers, *etc.*) and gathering feedback from them.

The methodologies to achieve the objectives O1 to O5 are summarized below.

O1 (Tailoring MBSR to Developers). To achieve this objective, we planned to conduct focus groups with software developers from the contact network of the project's partners. We opted for focus groups because they are known to be fast to be performed and

cost-effective to obtain qualitative insights [13]. O1 was pursued since we conducted three focus groups with software developers employed at our industrial partners and then gained insights into the job characteristics, both job demands and resources, that characterize SD and might affect well-being at work among software developers [17]. In total, the focus groups involved 21 developers from two multinational corporations operating in the software industry in Italy. We analyzed the gathered data (*i.e.,* personal notes and transcripts of the focus groups) through *template analysis* [12]. To drive our template analysis, we used a theoretical model widely used in the field of Work and Organizational Psychology: the *Job Demands-Resources* (*JD-R*) [5] model. We identified several job demands and resources that characterize SD (see Section 5). The gained insights guided us in designing a training intervention (*i.e.,* the ad-hoc MBSR protocol) capable of supporting software developers in improving their ability to effectively respond to the demands posed by their job and fully exploit the available job resources. In this view, the customization of the contents and exercises within the MBSR protocol will facilitate the transferring process of the acquired abilities to the SD working context.

O2 (Assessing Ad-hoc MBSR in Short Range). To pursue this objective, we are designing a multi-site (three-site, in particular) Randomized Control Trial (RCT). The RCT will start in the next few months with participants recruited, voluntarily, among the software developers employed at our industrial partners (*i.e.,* the same software companies we involved in the focus groups). A multi-site RCT, like ours, should allow reaching a higher number of participants as compared to a single-site RCT. The participants in the RCT will be asked to fill in a pre-questionnaire to better characterize them and then they will execute an SD-related task at the time T0 (*i.e.,* before the intervention). Later, they will be split into two experimental groups: *treatment* and *control*. The participants in the treatment group will undergo our ad-hoc MBSR protocol and then be asked to perform an SD-related task at the time T1 (*i.e.,* after the intervention). On the other hand, the control group, who will not undergo any mindfulness program, will be asked to perform the same task as the other group at the time T1. The SD-related task to be performed will be a bug-fixing one. We opted for a bug-fixing task since the gained insights from the focus groups showed that fixing bugs, especially when performed under time pressure, is very stressful for software developers. It is worth mentioning that we will conduct a pilot study, before the RCT takes place, to check and possibly improve the experimental material. The measurements will take place at the times T0 and T1. To better understand the mechanisms that regulate the relationships between our intervention and the outcomes of interest, we will take into account the following mediating and moderating factors: mindfulness trait, psychological capital, and personality traits. Moreover, we will collect, through a post-questionnaire, feedback from the participants about their experiences in the RCT.

O3 (Assessing Ad-hoc MBSR in Long Range). To achieve O3, we planned a follow-up study. More specifically, we will ask the participants of the RCT to carry out further tasks at the following times: T2 (one month after T1), and T3 (four months after T1). At each follow-up time, we will make the same measurements as T0 and T1. This is to assess the retention of the ad-hoc MBSR protocol (*i.e.,* the long-term effects of the intervention). Also, we will collect feedback from the participants through post-questionnaires.

O4 (Delineating Lessons Learned). We planned to triangulate the quantitative and qualitative data from all the studies of our project. To delineate the lessons learned, we will also take into account existing empirical evidence. The lessons learned will also include the experiences we will gain in the project. We plan to delineate the lessons learned through a series of iterations (*i.e.,* a series of meetings) among the research units of the projects.

O5 (Disseminating Knowledge and Gathering Feedback). To achieve O5, we planned to conduct a workshop with researchers and software professionals at the end of the project. Moreover, we aim to share knowledge through research papers and gather feedback from researchers and software professionals when presenting our papers at conferences—this paper is an example.

4 Project Structure

MOOD consists of five Work Packages (WPs), each addressing one of the MOOD's objectives, plus an additional WP devoted to project management and coordination (see Table 2).

5 Preliminary Results

We conducted three focus groups with software developers, which allowed us to identify the job characteristics, both job demands and resources, that characterize SD [17]. As for the job demands, we observed that software developers must continuously develop their problem-solving skills to fulfill the tasks at hand, which are unique in their nature of solution. Managing unpredictability is an additional concern that software developers are confronted with. Time pressure is considered an important stress factor: deadlines often overlap one another so that developers have to accomplish more work at the same time, adding further difficulty in time management; moreover, most work is categorized as "urgent". The job of the software developer also requires interacting with customers, colleagues, and superiors. These interactions lead software developers to cope with some sources of stress, such as external pressures and expectations, time management scheduled by others, and understanding requests that are unclear, incomplete, or do not fit the context. There are also work situations in which software developers feel the burden of responsibility (*e.g.,* when dealing with security risks). Moreover, software developers are subject to work-life conflicts such as difficulties in detaching from the problems they tackle at work or meetings arranged outside working hours. As for the job resources, we found (among other things) that software developers appreciate the autonomy in the organization of working time (*e.g.,* deciding whether to work in the office or remotely).

6 Expected Impact

MOOD is in line with the priorities of the *European Agency for Occupational Safety and Health at Work*,[1] which has highlighted the importance of identifying proper interventions to promote well-being and reduce stress in the workplace. As demonstrated, job-related stress can lead to serious health consequences for workers, negatively impacting healthcare costs, social welfare costs, and

[1] https://osha.europa.eu/en/themes/psychosocial-risks-and-mental-health

Table 2: Description of the MOOD's work packages.

WP1: Tailoring (M1-M8)[a]	
Objective:	Tailoring MBSR to Developers (O1)
WP Breakdown:	• Planning the focus groups (M1-M2) • Conducting the focus groups and analyzing the data (M3-M6) • Designing the ad-hoc MBSR protocol (M7-M8)
Deliverable(s):	Report on the gained insights from the focus groups and ad-hoc MBSR protocol (M8)
WP2: Short-range Experimentation (M8-M19)	
Objective:	Assessing Ad-hoc MBSR in Short Range (O2)
WP Breakdown:	• Planning the RCT and follow-up study (M8-M10) • Conducting a pilot study and reviewing the planning of the RCT and follow-up study (M11) • Conducting the RCT in the 1st site and analyzing the data (M12-M15) • Conducting the RCT in the 2nd site and analyzing the data (M16-M19) • Conducting the RCT in the 3rd site and analyzing the data (M16-M19)
Deliverable(s):	Report on the outcomes from the RCT (M19)
WP3: Long-range Experimentation (M15-M22)	
Objective:	Assessing Ad-hoc MBSR in Long Range (O3)
WP Breakdown:	• Conducting the follow-up study in the 1st site and analyzing the data (M15-M18) • Conducting the follow-up study in the 2nd site and analyzing the data (M19-M22) • Conducting the follow-up study in the 3rd site and analyzing the data (M19-M22)
Deliverable(s):	Report on the outcomes from the follow-up study (M22)
WP4: Lessons Learned (M20-M24)	
Objective:	Delineating Lessons Learned (O4)
WP Breakdown:	• Delineating the lessons learned (M20-M24).
Deliverable:	Report on the lessons learned (M24)
WP5: Dissemination (M7-M24)	
Objective:	Disseminating Knowledge and Gathering Feedback (O5)
WP Breakdown:	• Publishing research papers (M7-M24) • Organizing the workshop (M20-M23) • Conducting the workshop (M24)
Deliverable(s):	Report on the workshop (M24)
WP6: Management and Coordination (M1-M24)	
Objective:	Managing and coordinating partners and activities
WP Breakdown:	• Coordinating partners and activities (M1-M24)
Deliverable(s):	Intermediate project report (M12) and final project report (M24)

[a] "M" stands from "Month".

productivity.[2] The literature on peopleware has highlighted that job-related stress is an emerging risk among developers and that turnover represents a particularly relevant consequence for this working population [3]. The turnover is costly for the software industry [10]. Pekala [16] reported that United States firms pay more than $140 billion per year in recruiting, training, and administrative expenses to replace employees who leave. Cost studies show also that losing scientists or technical professionals (*e.g.,* developers) is three to six times the cost of losing administrative professionals and the employee turnover rate in the software industry is much higher than any other sector [10]. In this context, we foresee a positive impact of MOOD at different levels: *(i)* at a worker level, by promoting developers' well-being (*e.g.,* by reducing stress); *(ii)* at an organizational level, by improving developers' performance and quality of software-related artifacts and reducing developers' turnover; and *(iii)* at a societal level, by reducing the indirect cost caused by poor well-being at work (*e.g.,* developers experiencing burnout). Regarding the impact at a societal level, it is worth noting that the relevance of the software industry in the modern economy is increasing. For instance, in terms of occupational rate, a recent *Eurostat* report[3] indicated that 2.4 million people were employed in the European Union high-tech sector (which includes the software industry). In this context, we foresee that a positive impact of MOOD at a societal level can contribute to the sustainable development of the high-tech sector. For instance, positive MOOD outcomes can contribute to containing welfare costs that are due to poor well-being at work, and the development of a "healthy" software industry.

[2]https://osha.europa.eu/en/publications/calculating-cost-work-related-stress-and-psychosocial-risks

[3]https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Science_and_technology

Acknowledgments

This project entitled *"MOOD–Mindfulness fOr sOftware Developers"* (project number: D53D23008880006) is financially supported by the *Italian Ministry of the University and Research* (*MUR*) through the *Research Projects of Significant National Interest* (*PRIN*) program.

References

[1] Ghulam Abid, Irum Zahra, and Alia Ahmed. 2016. Promoting thriving at work and waning turnover intention: A relational perspective. *Futur. Bus. J.* 2, 2 (2016), 127–137.
[2] Victor Basili, Gianluigi Caldiera, and H Dieter Rombach. 2002. Goal Question Metric (GQM) Approach. In *Encyclopedia of Software Engineering*. Wiley, 528–532.
[3] Beatriz Bernardez, Amador Durán, José A Parejo, Natalia Juristo, and Antonio Ruiz-Cortés. 2020. Effects of mindfulness on conceptual modeling performance: A series of experiments. *IEEE Trans. Softw. Eng.* 48, 2 (2020), 432–452.
[4] Larry L Constantine. 1995. *Constantine on peopleware*. Yourdon Press.
[5] Evangelia Demerouti, Arnold B Bakker, Friedhelm Nachreiner, and Wilmar B Schaufeli. 2001. The job demands-resources model of burnout. *J. Appl. Psychol.* 86, 3 (2001), 499–512.
[6] Davide Fucci, Giuseppe Scanniello, Simone Romano, and Natalia Juristo. 2018. Need for sleep: the impact of a night of sleep deprivation on novice developers' performance. *IEEE Trans. Softw. Eng.* 46, 1 (2018), 1–19.
[7] Theresa M Glomb, Michelle K Duffy, Joyce E Bono, and Tao Yang. 2011. Mindfulness at work. In *Research in personnel and human resources management*. Vol. 30. Emerald, 115–157.
[8] Daniel Graziotin, Xiaofeng Wang, and Pekka Abrahamsson. 2015. Do feelings matter? On the correlation of affects and the self-assessed productivity in software engineering. *J. Softw.: Evol. Process* 27, 7 (2015), 467–487.
[9] Stephanie D Jamieson and Michelle R Tuckey. 2017. Mindfulness interventions in the workplace: A critique of the current state of the literature. *J. Occup. Health Psychol.* 22, 2 (2017), 180–193.
[10] James J Jiang and Gary Klein. 2001. Software project risks and development focus. *J. Proj. Manag.* 32, 1 (2001), 4–9.
[11] Jon Kabat-Zinn. 2003. Mindfulness-Based Interventions in Context: Past, Present, and Future. *Clin. Psychol. Sci.* 10, 2 (2003), 144–156.
[12] Nigel King. 2012. Doing template analysis. In *Qualitative organizational research: Core methods and current challenges*. Sage, 426–450.
[13] Jyrki Kontio, Johanna Bragge, and Laura Lehtola. 2008. The Focus Group Method as an Empirical Tool in Software Engineering. In *Guide to Advanced Empirical Software Engineering*. Springer, 93–116.
[14] Tim Lomas, Juan Carlos Medina, Itai Ivtzan, Silke Rupprecht, and Francisco José Eiroa-Orosa. 2018. A systematic review of the impact of mindfulness on the well-being of healthcare professionals. *J. Clin. Psychol.* 74, 3 (2018), 319–355.
[15] Jan-Peter Ostberg, Daniel Graziotin, Stefan Wagner, and Birgit Derntl. 2017. Towards the assessment of stress and emotional responses of a salutogenesis-enhanced software tool using psychophysiological measurements. In *2017 IEEE/ACM 2nd International Workshop on Emotion Awareness in Software Engineering (SEmotion)*. IEEE, 22–25.
[16] Nancy Pekala. 2001. High-Tech, High-Touch Screening Sifts Out Quality Applicants. *J. Prop. Manag.* 66, 2 (2001), 82–82.

[17] Simone Romano, Alberto Conforti, Gloria Guidetti, Sara Viotti, Daniela Converso, and Giuseppe Scanniello. 2024. On Job Demands and Resources in the Italian Software Industry: Initial Insights from a Qualitative Study. Pre-print: https://drive.google.com/file/d/14Sf0P0XDD4dUPL_bGhQ1pFEzq1MD3y6T/view?usp=drive_link.

[18] Simone Romano, Giuseppe Scanniello, Maria Teresa Baldassarre, Danilo Caivano, and Genoveffa Tortora. 2023. On Fixing Bugs: Do Personality Traits Matter?. In *Product-Focused Software Process Improvement: 24th International Conference, PROFES 2023, Dornbirn, Austria, December 10–13, 2023, Proceedings, Part I*. Springer, 451–467.

[19] Simone Romano, Giuseppe Scanniello, Davide Fucci, Natalia Juristo, and Burak Turhan. 2018. The effect of noise on software engineers' performance. In *Proceedings of the 12th ACM/IEEE international symposium on empirical software engineering and measurement*. ACM, 1–10.

[20] Ruben Vonderlin, Miriam Biermann, Martin Bohus, and Lisa Lyssenko. 2020. Mindfulness-based programs in the workplace: a meta-analysis of randomized controlled trials. *Mindfulness* 11 (2020), 1579–1598.