

MOOD STATES AND STUDENT LEARNING IN PROJECT MANAGEMENT: VALIDATING AND EXTENDING PRIOR RESEARCH WITH NEW DATA

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ABSTRACT

Practical experience is a key component of teaching and learning in project management. In 2023–2025, we organized two practical project management seminars as part of a bachelor's introductory project management course. In these seminars, we used serious management games to practise waterfall and agile approaches and to improve students' teamwork, communication, and soft skills. We applied the Profile of Mood States method to evaluate changes in total mood and individual mood factors during the seminars. We collected and analysed data from 2024–2025 ($n_{24} = 139$, $n_{25} = 98$) and compared these results with prior findings from 2023 ($n_{23} = 49$). We found that students' total mood improved significantly during both waterfall and agile seminars in all eligible years. Fatigue, depression, and confusion decreased significantly for both seminar types in all years, and tension decreased in most seminars. We will use these results to further improve the practical seminars and to introduce the solution to other areas.

KEYWORDS

Education, project management, Profile of Mood States, Scrum, serious management games

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Highlights

- We organized practical project management seminars for students in 2023–2025.
- We used serious waterfall and agile project management games in the seminars.
- Participants' total mood improved during waterfall and agile seminars in all years.
- Fatigue, depression, and confusion decreased during waterfall and agile seminars in all years.

INTRODUCTION AND LITERATURE REVIEW

In our prior research, we conducted a pilot study with a limited number of participants in 2023 to determine whether the serious management games used in practical seminars had a positive impact on mood, teamwork, and performance (Kunhart and Bartoška, 2025). We now aim to support and reinforce these findings using new datasets and to extend the research by providing a detailed analysis of individual mood factors. In this section, we describe the necessary background and context leading to the research gap and objectives addressed in this study.

Project management

Project management is a structured discipline concerned with the planning, execution, and control of temporary endeavors undertaken to achieve defined objectives within constraints of

time, cost, and scope Project Management Institute (2026). It can also be understood as the application of specific processes and principles to initiate, plan, execute, and manage how new initiatives or changes are implemented within an organization (AXELOS, 2023). As organizations increasingly operate in complex and dynamic environments, effective project management has become a critical competency across a broad range of industries, including construction, manufacturing, software development, and public administration. The growing demand for skilled project managers has, in turn, placed considerable pressure on higher education institutions to provide not only theoretical instruction but also experiential learning opportunities that mirror professional practice. Moreover, the behavior of individual human agents within project activities has a decisive influence on project outcomes, as responses to deadlines and workload are shaped by phenomena

such as Student syndrome and Parkinson's law (Bartoška and Šubrt, 2012). At the methodological level, project management approaches can be classified along a spectrum ranging from plan-driven to change-driven paradigms. The plan-driven, or waterfall, model traces its conceptual roots to Royce (1987), who described a sequential, phase-gated development process in which each stage, namely requirements, design, implementation, verification, and maintenance, is completed before the next begins. Its strengths lie in environments where requirements are well defined and unlikely to change during the project. However, its inherent rigidity makes it less suitable for projects characterized by uncertainty, evolving stakeholder needs, or the need for rapid iteration.

In response to these limitations, which culminated in the software development crisis of the 1990s (Shore, 2021), the software industry developed a fundamentally different philosophy of project delivery, articulated in the Agile Manifesto (Beck et al., 2001). Agile prioritizes individuals and interactions, working software, customer collaboration, and responsiveness to change. Among the agile frameworks that have since emerged, Scrum has become the most widely adopted in professional practice in software development and other fields (Digital.ai, 2024; Hobbs and Petit, 2017; Hron and Obwegeser, 2022). Scrum structures project work into short, time-boxed iterations called Sprints, with clearly defined roles and a set of events, including Planning, Daily Scrum, Reviews, and Retrospectives (Schwaber and Sutherland, 2012; Sutherland, 2014). This iterative cadence fosters continuous feedback, adaptive planning, and a high degree of team autonomy. Empirical evidence suggests that agile projects tend to outperform their waterfall counterparts in schedule adherence and stakeholder satisfaction, particularly in software-intensive domains (Chow and Cao, 2008; Prasetya et al., 2021), although the effectiveness of either approach remains contingent on organizational context, team maturity, and the nature of the project (Ciric et al., 2019).

The distinction between waterfall and agile reflects fundamentally different assumptions about how teams organize, communicate, and respond to uncertainty. Waterfall projects tend to involve clearly delineated individual responsibilities and infrequent cross-functional collaboration, whereas agile teams are expected to self-organize, continuously negotiate priorities, and maintain high levels of interpersonal coordination across short delivery cycles (Dingsøyr et al., 2012). These structural differences give rise to distinct patterns of cognitive load, emotional engagement, and social dynamics among team members, including opinion formation and consensus-building processes within small groups (Horáček, 2025), all of which are difficult to convey through lecture-based instruction alone. Effective preparation for professional project management therefore requires direct exposure to both paradigms, ideally within a controlled learning environment that preserves the essential characteristics of each approach while allowing for systematic observation and assessment (Hellström et al., 2023; Rumeser and Emsley, 2019). We designed the practical seminars with this rationale in mind: to immerse students in authentic waterfall and agile project experiences and to evaluate the behavioral and affective outcomes of that immersion using a validated psychometric instrument.

Profile of Mood States overview

The Profile of Mood States (POMS) is a psychological rating scale and method designed to measure transient moods and evaluate changes in mood states. McNair et al. (1971) developed and introduced the original POMS in 1971. POMS moods are short-term states that affect human behavior, health, and well-being; they are often unrelated to external events and can vary in intensity (Searight and Montone, 2017). POMS allows for a quick and efficient assessment of changes in participants' mood states during the assessed activity. The method is used through interventions consisting of two variants. Each participant completes the first questionnaire (variant A) before the observed activity and the second questionnaire (variant B) after the activity. Each questionnaire takes 5–10 minutes to complete. Jones et al. (2010) note that multiple interventions are commonly used to evaluate mood changes over a specific period. POMS has been used in more than four thousand published studies (Bourgeois et al., 2010). The original version of POMS was intended for adults and included 65 questions. It was subsequently revised and adapted to specific needs. In 1983, Shacham published POMS-SF, which includes 37 questions and addresses shortcomings of the original version, particularly its excessive length, while maintaining reliability and accuracy. Curran et al. (1995) validated POMS-SF and stated that it can be considered an excellent alternative to the original POMS when a brief measure of psychological distress is required. In 2012, Heuchert and McNair published a revised version, POMS 2 (Heuchert and McNair, 2012). However, unlike earlier versions, the POMS 2 scoring keys and instructions are proprietary, and both paper and online questionnaires must be evaluated exclusively using the publisher's online tool (Boyle et al., 2015). POMS is chiefly used to assess mood changes in sports, such as athletics and general physical activity (Berger and Motl, 2000; Heikura et al., 2023; Pang et al., 2023). Research shows that physical activity is positively related to mood states and perceived health, with moderate physical activity showing particular benefits for psychological well-being (Reigal et al., 2021). Beyond sports, researchers have used the method in diverse fields, ranging from management and decision-making, where human factors remain central to operations research and management science (Weber et al., 2020), to investigations of building occupants' perceptions of thermal environments (Özbey and Turhan, 2025). Since its introduction in 1971, other POMS variants have emerged, including POMS-Fatigue by Johnson et al. (2019) and POMS-16, a 16-item version for brief and cost-effective assessment by Petrowski et al. (2025). POMS has been adapted and validated in more than 42 languages (Boyle et al., 2015). The Czech version of POMS by Stuchlíková et al. (2005) is based on POMS-SF. The authors tailored and psychologically verified the Czech version for Czech target groups. The questions in the Czech questionnaire may differ from exact translations of the original POMS questions. A complete list of questions in the original and Czech versions of POMS is provided in Table 9 in Appendix A.

Serious management games

A serious game is a game intended for purposes beyond entertainment, typically with educational, training, or simulation objectives. According to De Gloria et al. (2014),

serious games are attracting increasing interest in education and training because they can contextualize players' experiences in challenging, realistic environments and promote situational learning. In management, serious management games are used to develop skills and knowledge relevant to project management practice (Djaouti et al., 2011). In project management, management games involve hands-on building activities that provide firsthand experience and improve skills that are difficult to teach through traditional methods (Hellström et al., 2023). Serious management games are also valuable tools for gamifying leadership learning. By providing an engaging learning environment, these games can significantly improve the development of leadership and soft skills (Kesti et al., 2022). Active learning in project management encourages collaboration, teamwork, and project simulation through management games and practical experience (Paasivaara and Lassenius, 2014; Miller and Vaca Núñez, 2022). Key elements of effective management games include realism, feedback loops, adaptability, communication, and personalization. Rumeser and Emsley (2019) recommend that researchers and educators move toward simulating soft project knowledge areas. In addition, management games are used to create risk-free experimental settings (Hellström et al., 2023), unlike real-world projects where delayed or expedited activities carry tangible penalties and bonuses that affect team performance (Branzei et al., 2011). In agile contexts, serious project management games often involve physical building activities using building kits (Paasivaara et al., 2014; Barcelos Bica and Gouvea da Silva, 2020) and office tools such as paper, scissors, and crayons to teach agile principles and help students understand concepts of agile and the Scrum method (Havazik and Pavlíčková, 2020). Studies focused on serious games in project management have shown that these games can lead to educational changes, such as a shift toward active pedagogies, the development of new soft-skill competencies, and changes in teacher-student relationships (Jaccard et al., 2022). Young Illies and Stachowski (2020) report that students often receive limited teamwork training, but when they do receive such training, it is well received. Fernandes et al. (2021) suggest that research on the application of Scrum in education remains scarce and mostly exploratory, and that empirical studies using Scrum to improve learning in higher education are rare.

Research gap and objectives

Our research goal is to verify and strengthen the results of our 2023 pilot study using new datasets from 2024 and 2025. The research gap lies in the lack of studies that use POMS to this extent in project management education or practice. To fulfill our research goal, we formulated three research questions:

- RQ1: Did the total mood of participants improve during the waterfall and agile project management seminars?
- RQ2: Did any individual factors improve significantly during the waterfall and agile project management seminars?
- RQ3: Are the results of total mood improvement consistent across all years in which we conducted the current and prior research?

We formulated RQ1 similarly to our prior research to support

and reinforce our previous findings from 2023 using new datasets from seminars in 2024 and 2025. We added RQ2 to investigate changes in all factors. Finally, we added RQ3 to reflect and support the main research goal. We formulated four null and four alternative hypotheses to support our research questions. The null hypotheses are:

- $H1_0$: Total mood of participants did not improve during waterfall seminars.
- $H2_0$: Total mood of participants did not improve during agile seminars.
- $H3_0$: the factor did not improve during waterfall seminars.
- $H4_0$: the factor did not improve during agile seminars.

The related alternative hypotheses are:

- $H1_1$: Total mood of participants improved during waterfall seminars.
- $H2_1$: Total mood of participants improved during agile seminars.
- $H3_1$: the factor improved during waterfall seminars.
- $H4_1$: the factor improved during agile seminars.

Hypotheses H1 and H2 support RQ1 and are consistent with prior research. Hypotheses H3 and H4 support RQ2 and partially correspond to the part of prior research that examined only vigor and fatigue. We tested hypotheses H3 and H4 separately for each factor. We tested all hypotheses for both years and datasets, i.e., 2024 and 2025. For RQ3, we answered the research question by comparing the results between years. Our research reinforces our prior findings and contributes to improving practical project management teaching.

MATERIALS AND METHODS

POMS method

We used the POMS method to calculate TMD and factor scores. POMS questionnaires use a list of questions that include adjectives describing participants' current mood states. The questions use a five-point Likert scale (Likert, 1932) with the following response options: not at all, a little, moderately, quite a lot, and extremely. Most answers are encoded as integer values from 0 to 4, with a few exceptions encoded from 4 to 0. The Czech version includes 37 questions. From the bottom up, individual questions are aggregated into six dimensions of mood states corresponding to six factors: anger-hostility, fatigue-inertia, vigor-activity, depression-dejection, confusion-bewilderment, and tension-anxiety. Spielberger (1972) states that POMS is unique in providing measures of vigor-activity, fatigue-inertia, and confusion-bewilderment. In the following text, we refer to the factors only by their initial terms, i.e., vigor. The factors aggregate into the Total Mood Disturbance (TMD) score. Total Mood Disturbance is calculated as the sum of partial scores for all factors. A higher TMD score indicates a higher level of mood disturbance; in other words, the higher the number, the worse the mood. Formula 1 presents the equation.

$$TMD = (anger + fatigue + depression + confusion + tension) - vigor \quad (1)$$

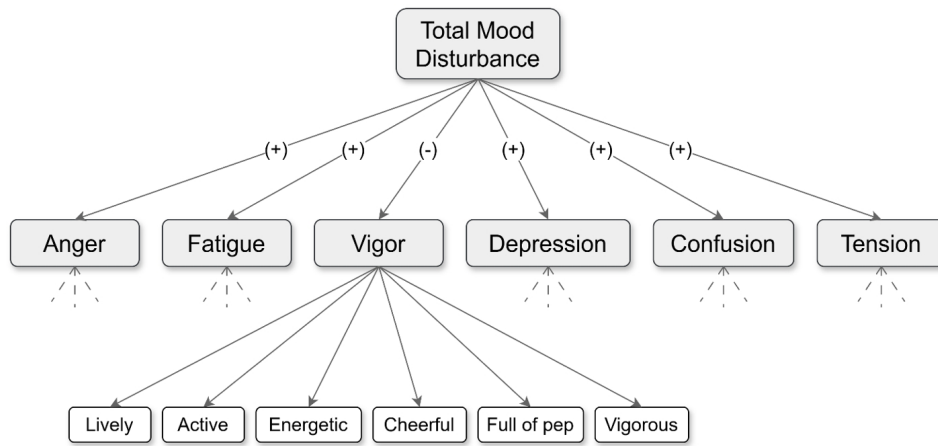


Figure 1: Total Mood Disturbance, factors, and questions (adjectives) for vigor. Source: own.

TMD is calculated by adding the partial scores for tension, depression, anger, fatigue, and confusion and then subtracting the partial score for vigor (McNair et al., 1971). Most factors represent mood disturbance and add to the score, whereas vigor represents mood improvement and is therefore subtracted. A constant of 100 is added to the TMD score to eliminate negative scores (Sahli et al., 2020). Individual factors are calculated according to the scoring instructions and weights for POMS (McNair et al., 1971). The Czech version of POMS uses the same calculations for TMD and factors as the original version described above. However, the weights of individual questions have been adapted for Czech respondents. For details, see Stuchlíková et al. (2005). For the seminars, we used the Czech version of POMS because the target group for this research was students enrolled in Czech study programs. The seminars included both physical and mental activities. Relevant studies state that physical activity positively correlates

with improvements in participants' mental health (Berger and Motl, 2000; White et al., 2017). POMS is therefore a suitable psychological method for evaluating teamwork during project management games.

POMS Online

To conduct our research, we used POMS Online (Kunhart, 2025). POMS Online is a software solution that implements the POMS method. This solution builds on the ad hoc prototype that we used in 2023/24. The solution supports questionnaire management, data collection, and data export for data analysis. POMS Online consists of a back-end application and a front-end application, which communicate via a standard REST¹ API². The back-end application supports administration and database functions. The front-end application is used for data collection via forms. Figure 2 displays the entity model of the software solution.

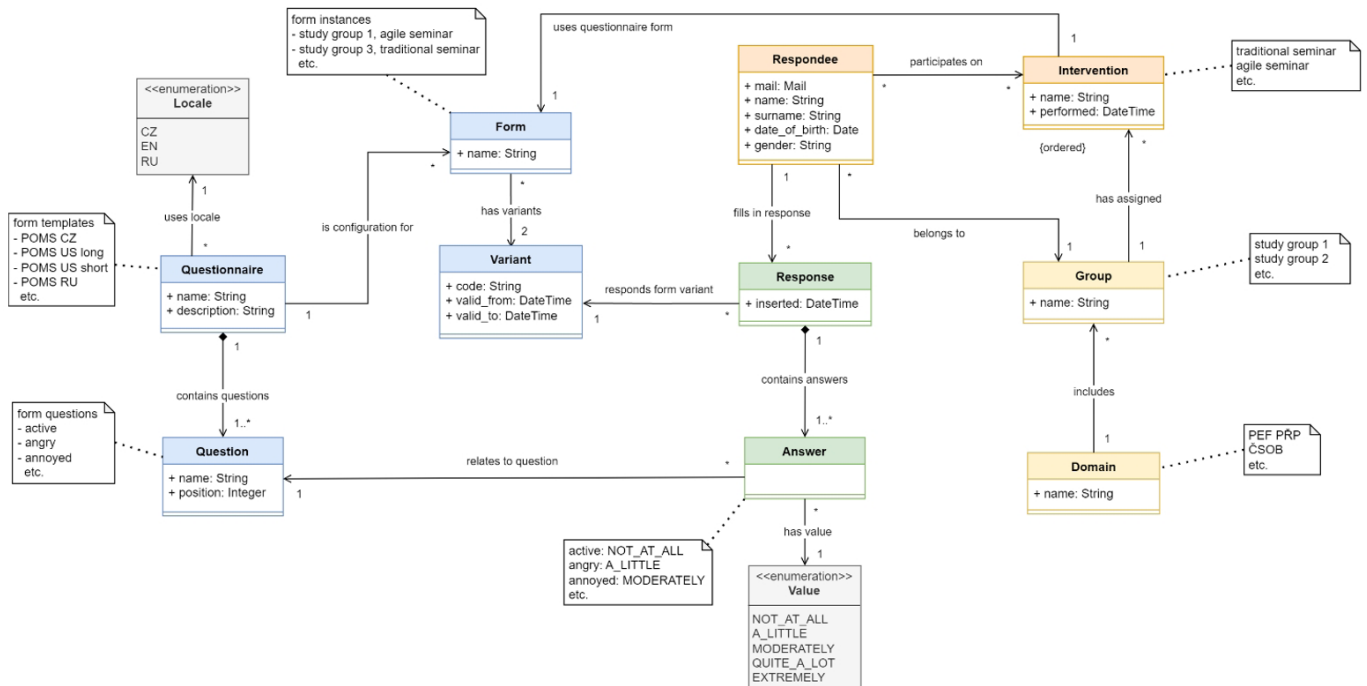


Figure 2: Entity model for POMS Online application. Source: Kunhart (2025).

- 1 Representational State Transfer.
- 2 Application Programming Interface.

The entity model can be divided into three primary areas:

- Back-office entities (yellow and orange).
- Questionnaire entities (blue).
- Response entities (green).

Back-office entities are used for research management, i.e., defining domains, research groups, and interventions. Questionnaire entities are used to define POMS questionnaires, i.e., the Czech version of POMS, and to prepare concrete forms. Response entities represent concrete responses and answers completed by participants. To complete the form, each participant first enters a code that is unique to the given form and its variant. The code is provided by the research coordinator. After the code is verified, the participant answers the questions valid for the form, and the response is saved to the database. For further details about the implementation and user interface of the POMS Online solution, please refer to Kunhart (2025).

Practical project management seminars

We organized two new pairs of practical project management seminars in 2024 and 2025. For the purposes of this research, we define “seminars” as sets of lessons for multiple study groups of students on the same topic, i.e., the waterfall or agile approach, organized over a two-week period under similar working conditions. The practical seminars form an integral part of the Planning and Project Management course at the Faculty of Economics and Management of the Czech University of Life Sciences Prague, which takes place in the fall semester. We therefore conducted the survey in November and December. Each year, we organized one waterfall seminar and one agile seminar and evaluated students’ teamwork in both approaches. Each approach is better suited to distinct types of projects and involves different kinds of interaction and emotional states within teams. We used serious management games for the seminars, and the activities included both physical activities and soft-skills practice. For most students, the seminars represented their first practical project management experience. In both seminars, students worked in the same project teams of 4–6 members.

In the first seminar, the management game involved building a model of a medieval castle using the waterfall approach. The main goal of the management game was to build a representative castle for the Czech king, and students were presented with a list of functional and non-functional requirements, such as “at least two towers” and “indomitable walls”. Each team selected a project manager and prepared a project plan in advance, including a work breakdown structure with all tasks and estimates. Once construction had begun, the team could no longer change the plan. Students used tools such as paper, scissors, crayons, and wooden skewers to build the castle. They spent approximately 15 minutes planning and 60 minutes building. In the second seminar, the management game involved building an amusement park from LEGO components using a simplified Scrum method. In this seminar, we did not define precise requirements in order to support creativity and innovation. Instead, we presented students with real-world

examples as inspiration. Students frequently added new user stories for innovative ideas that emerged during the game. Each team selected a Product Owner and a Scrum Master, prepared a short initial Product Backlog, and worked in Sprints. Due to limited seminar time, we used a simplified version of Scrum that merged all events, i.e., Planning, Review, and Demo. Students spent approximately 10 minutes preparing the initial backlog and 65 minutes building. The teams completed 3–4 Sprints during the seminar. We used the remaining 15 minutes of both seminars for instructions, questionnaires, and presentations of castles and amusement parks to other teams.

Questionnaire survey design

We prepared a pair of questionnaires for each seminar to evaluate changes in students’ mood states during the management games and between waterfall and agile seminars. We used the POMS Online solution to set up the questionnaires. At the beginning of each seminar, we introduced the students to the management game and the purpose of our research, which is to continuously improve the quality of project management teaching and practical seminars. The students filled out the first questionnaire form (variant A) after the introduction, before the start of the management game, and the second questionnaire form (variant B) after it ended. The questionnaire forms used the Czech version of POMS and contain 37 questions with Czech adjectives. We named each form accordingly, e.g., waterfall seminar, 18. November 2025, 2:00 PM, form variant A, and published it for a limited time that matched the seminar schedule. We used online forms in POMS Online for the questionnaires and QR³ codes to deliver the questionnaires to the students. In the survey, we collected students’ university e-mail addresses and their responses. E-mail addresses are required because they serve as unique identifiers that link responses between form variants and seminars. We did not collect any other personal information.

Data processing and analysis

We collected quantitative primary data through the questionnaire forms in POMS Online front-end versions 1.1.0 and 1.2.0. After completing all the seminars, we processed the data. Data processing and analysis involved three steps: data collection, data transformations, and statistical analysis (see Figure 3). We used POMS Online back-end 2.0.1 to save form data. We used the Forms module in POMS Online to export the data. We exported one dataset for responses in 2024, and one dataset for responses in 2025. The exported data in CSV⁴ format includes all answers, calculated factor scores, and calculated TMD scores. Data transformations include data fixes, cleanup, and anonymization. In data fixes, we reviewed e-mail addresses, converted them to lowercase, and fixed typos such as mismatched letters or e-mail domains that could have prevented correct pairing of the responses between variants and seminars. During data cleanup, we removed ineligible records. In order to compare the changes in respondents’ mood states between the variants and the seminars, we required them to complete four questionnaire forms (two form variants for

3 Quick Response.

4 Comma-Separated Values.

two seminar types). Therefore, we removed respondents with fewer than four responses. Finally, we anonymized all e-mail

addresses using one-way hash. We performed data fixes, cleanup, and transformations in Excel and Python 3.14.



Figure 3: Steps for questionnaire data collection and statistical analysis. Source: own.

We used the datasets in CSV format for statistical analysis. First, we confirmed that the datasets conformed to a normal distribution to allow hypothesis testing. For normality confirmation, we used the normaltest function from SciPy and visually checked the distribution of the data. To maintain consistency with our prior research methodology, we tested the hypotheses formulated in the research objectives using a two-sided Wilcoxon signed-rank test for the difference between two paired data samples (Wilcoxon, 1945). In our prior research, we selected this non-parametric test due to small sample size and slight skewness. Although the current dataset contains a substantially increased number of observations and exhibits normal distribution characteristics suitable for parametric tests, we retained the Wilcoxon test to ensure methodological consistency between our prior and current studies. We used the wilcoxon function from SciPy for the statistical tests and set the same significance threshold of 0.05. For statistical analysis, we used Python 3.14 and the Jupyter ecosystem, including Jupyter core 5.9.1, pandas 3.0.1, NumPy 2.4.3, and SciPy 1.17.1.

RESULTS

In the current research, we collected data from 2024–2025. In 2024, we collected data from 139 eligible respondents, and in 2025, we collected data from 98 eligible respondents. Each eligible respondent completed four questionnaire forms, as described in the methods.

We therefore collected 556 distinct records in 2024 and 392 records in 2025. Each record includes factor scores and TMD scores, which were necessary for further calculations and statistical tests.

Total mood improvement during seminars

First, we evaluated changes in participants’ mood states during waterfall and agile seminars. For this evaluation, we compared TMD scores between the start of the management game (variant A) and after its end (variant B). A lower TMD indicates better mood and vice versa. Thus, a decrease in TMD score indicates an improvement in participants’ mood, whereas an increase indicates deterioration. Table 1 presents descriptive statistics for TMD scores in 2024. The table displays the sample size for 2024 ($n_{24} = 139$), mean, standard deviation, variance, and minimum and maximum values for each seminar type and variant. Mean values decreased for both seminar types, indicating a total mood improvement among participants in both cases. For waterfall seminars, the mean value decreased from 132.55 to 127.31 during the seminars, and for agile seminars, the mean value decreased from 126.59 to 123.73. Both changes were associated with increases in standard deviation and variance. In addition, scores for waterfall seminars were higher for both variants, indicating a worse mood state of participants both before and after the management game. The most extreme values were associated with agile seminars and variant B.

2024		<i>n</i>	mean	std dev	var	min	max
Waterfall seminars	Variant A	139	132.55	13.52	184.15	112	192
	Variant B	139	127.31	18.14	331.55	106	212
Agile seminars	Variant A	139	126.59	16.04	259.03	100	198
	Variant B	139	123.73	18.17	332.72	100	228

Table 1: Descriptive statistics for TMD scores in 2024. Source: own.

Table 2 presents descriptive statistics for TMD scores in 2025. The table displays the sample size for 2025 ($n_{25} = 98$), mean, standard deviation, variance, and minimum and maximum values for each seminar type and variant. Similarly to 2024, mean values decreased for both seminar types, indicating total mood improvement among participants in both cases. For waterfall seminars, the mean value decreased from 138.99 to 132.76 during the seminars, and for agile seminars, the mean value decreased

from 131.13 to 127.27. Both changes were associated with increases in standard deviation and variance, although the increase was lower than in 2024. Scores for waterfall seminars were higher for both variants, indicating a worse mood state of participants both before and after the management game. The lowest scores were associated with agile seminars, whereas the highest score was associated with waterfall seminars and variant B. Complete descriptive statistics are provided in Tables 1 and 2.

2025		<i>n</i>	mean	std dev	var	min	max
Waterfall seminars	Variant A	98	138.99	17.89	323.29	108	190
	Variant B	98	132.76	19.54	385.75	105	214
Agile seminars	Variant A	98	131.13	17.94	325.00	100	181
	Variant B	98	127.27	18.09	330.57	100	184

Table 2: Descriptive statistics for TMD scores in 2025. Source: own.

For a visual comparison between both years, see Figure 4. In the chart, the *x*-axis represents seminars, and the *y*-axis represents TMD scores. The bars represent TMD scores for a given year and seminar type, whereas the error bars represent the standard deviations for these TMD scores.

We tested the first two hypotheses, H1 and H2, to determine whether participants' total mood improved significantly during the seminars. H1 covered the waterfall seminars, and H2 covered the agile seminars. For H1, which concerned waterfall

seminars, we found statistically significant differences in TMD scores for both 2024 and 2025, with *p*-values lower than 0.001. Both *p*-values were below the threshold of 0.05, confirming H1₁ for both years. For H2, which concerned agile seminars, we also found statistically significant differences in TMD scores for both 2024 and 2025, with *p*-values of <0.001 and 0.0041. Both *p*-values were below the threshold of 0.05, confirming H2₁ for both years. Table 3 provides complete test statistics and details.

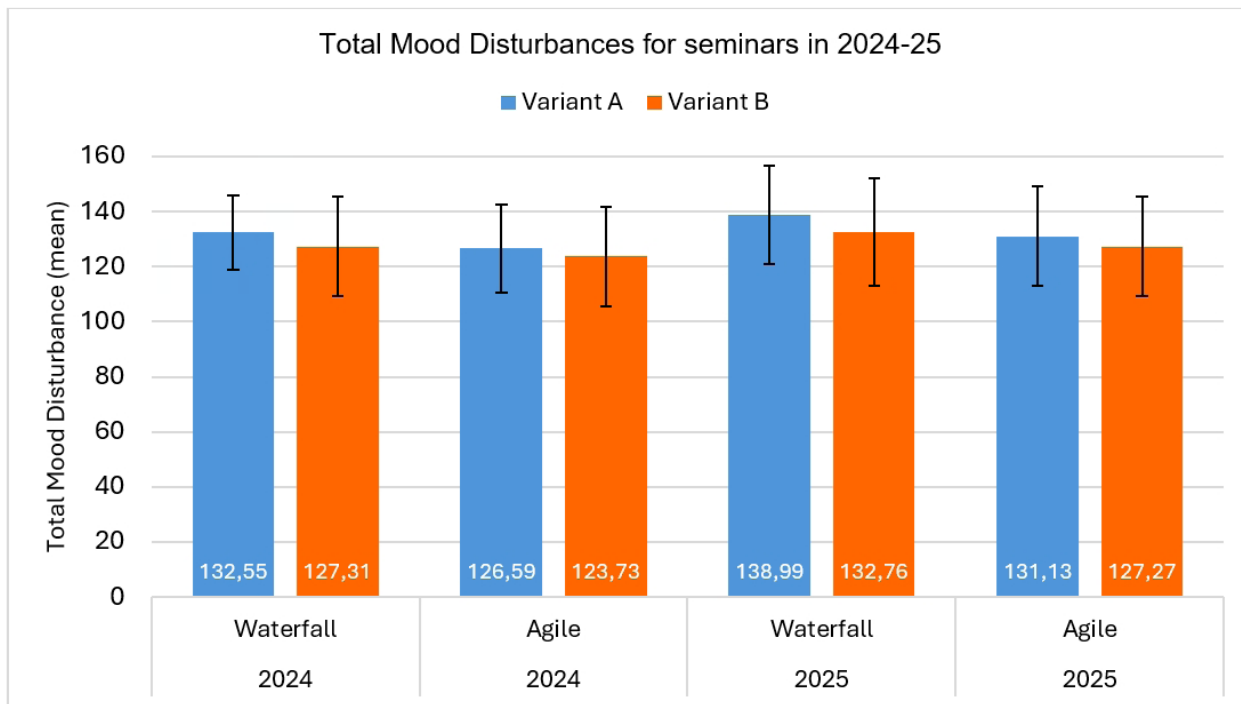


Figure 4: TMD scores for all seminars in 2024-25. Source: own.

2024-25		hypothesis	statistic	<i>p</i> -value	confirmed
Waterfall seminars	2024	H1 ₁	1777.5	< 0.001	yes
	2025		1155.5	< 0.001	yes
Agile seminars	2024	H2 ₁	2513.0	< 0.001	yes
	2025		1367.5	0.0041	yes

Table 3: Statistical test results for total mood change between variants A and B in 2024 and 2025. Source: own.

Based on the results of testing hypotheses H1 and H2, we can answer RQ1 as follows: participants' total mood improved during both waterfall and agile project management seminars. The results indicate that practical project management seminars and management games have a positive effect on participants' mood.

Individual factor improvements

Next, we analysed changes in all individual factors during the seminars: anger, fatigue, vigor, depression, confusion, and tension. In the analysis, we compared individual factor scores between variants A and B of the questionnaires. For all factors except vigor, a decrease in score indicates an improvement in the factor and vice versa. For example, a lower anger score indicates lower participant anger during the seminar. For

vigor, however, this logic is reversed. A decrease in vigor score indicates deterioration in participants' energy during the seminar. Lower overall scores for anger, confusion, depression, and tension correspond to a smaller number of questions contributing to these scores than for fatigue and vigor. Figures 5 and 6 present factor scores (means) for waterfall and agile seminars in 2024. In the charts, the *x*-axis represents the six factors, and the *y*-axis represents factor scores. During waterfall seminars, all factors improved (vigor increased, while the other factors decreased). During agile seminars, all factors except anger improved; anger worsened only slightly. Both charts provide visual details. Descriptive statistics for all factors in 2024 are available in Table 10 in Appendix B and include the sample size ($n_{24} = 139$), standard deviation, variance, and minimum and maximum scores.

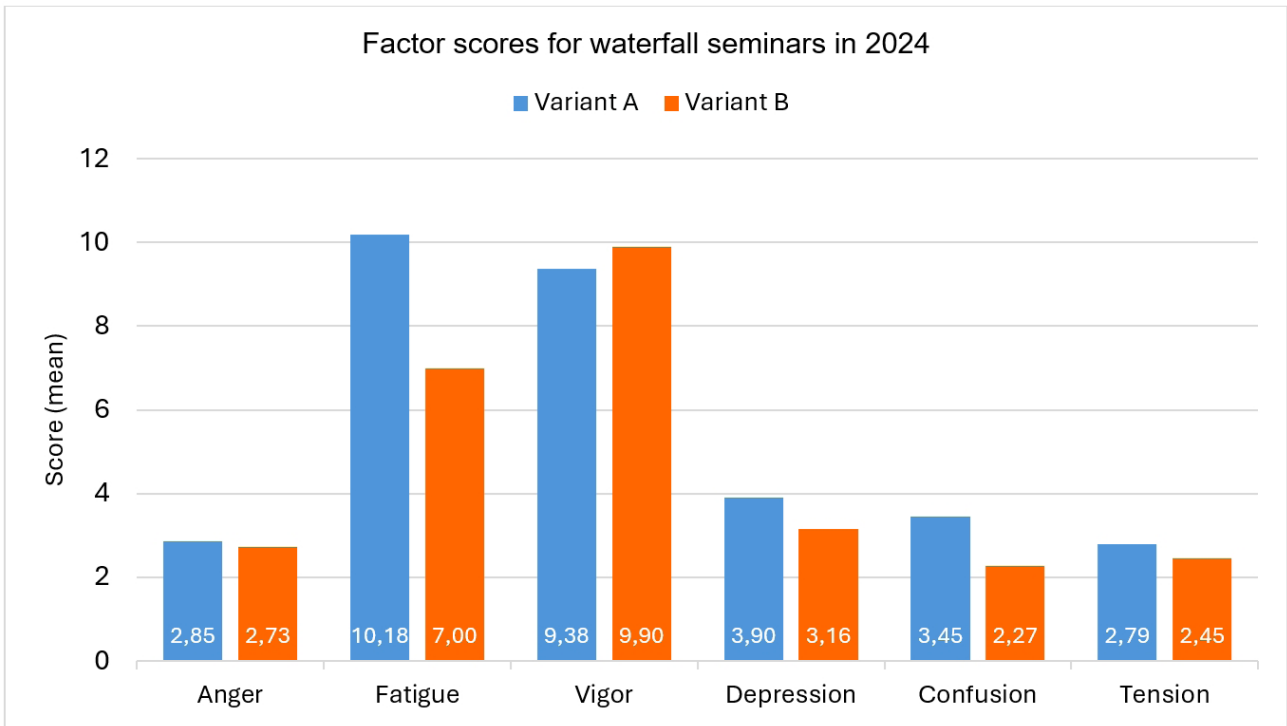


Figure 5: Factor scores for waterfall seminars in 2024. Source: own.

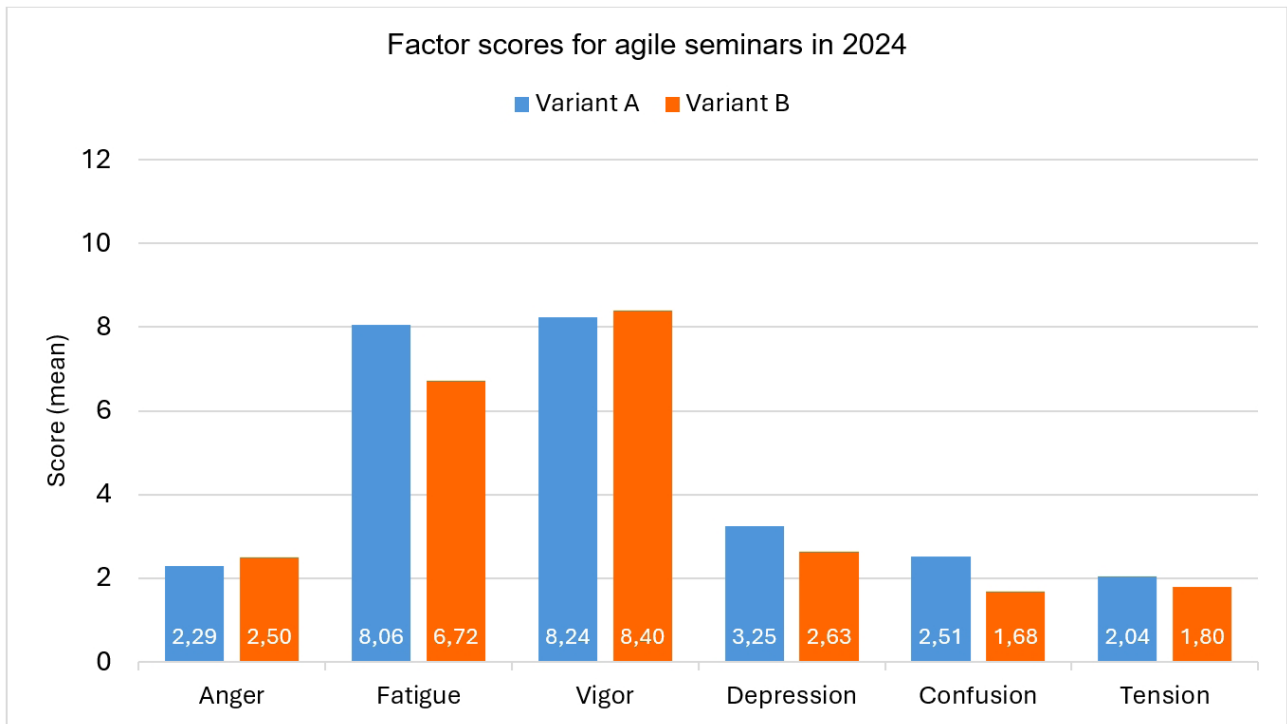


Figure 6: Factor scores for agile seminars in 2024. Source: own.

Figures 7 and 8 present factor scores (means) for waterfall and agile seminars in 2025. The charts present information similar to that for 2024, with the x-axis representing the six factors and the y-axis representing factor scores. During waterfall seminars, most factors improved, with only vigor worsening slightly. During agile seminars, all factors improved. Both charts provide visual details. Descriptive statistics for all factors in 2025 are available in Table 11 in Appendix B and

include the sample size ($n_{25} = 98$), standard deviation, variance, and minimum and maximum scores.

In hypotheses H3 and H4, we tested whether the changes and improvements described above and visualized in Figures 5–8 were significant. In H3, we tested all six factors during the waterfall seminars, and in H4, we tested all six factors during the agile seminars. For 2024, we found statistically significant differences in factor scores for both waterfall and

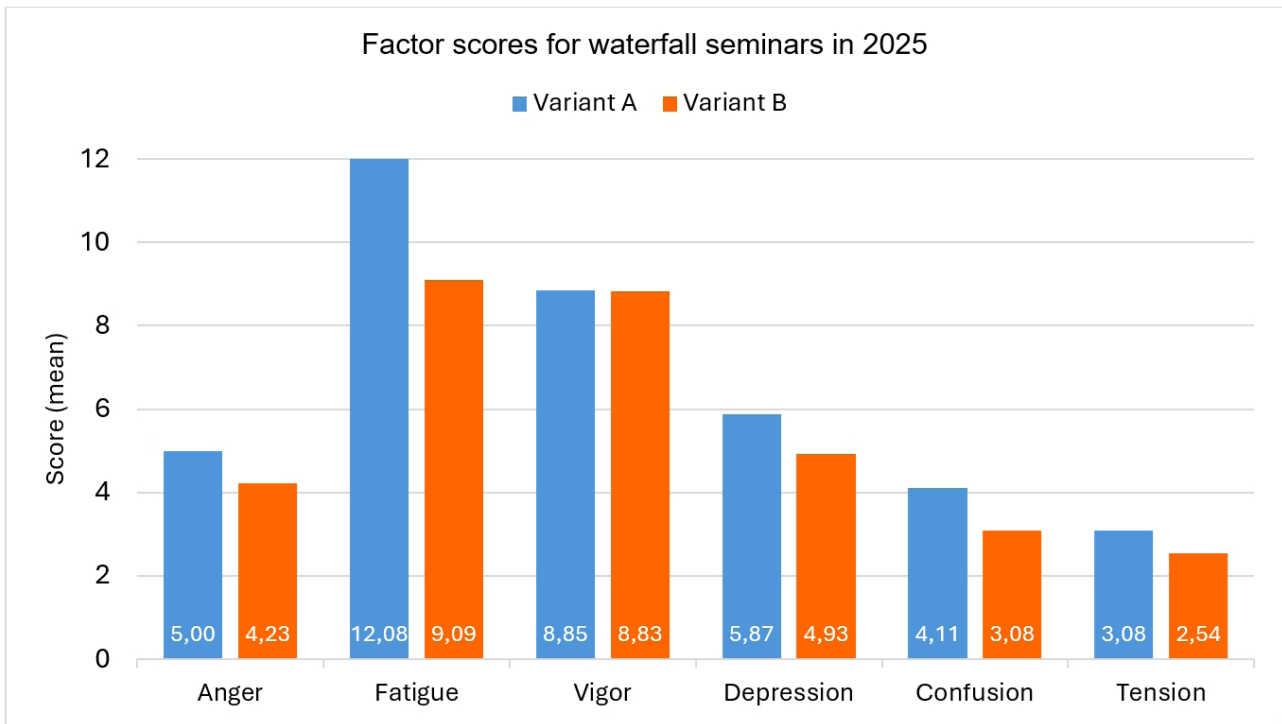


Figure 7: Factor scores for waterfall seminars in 2025. Source: own.

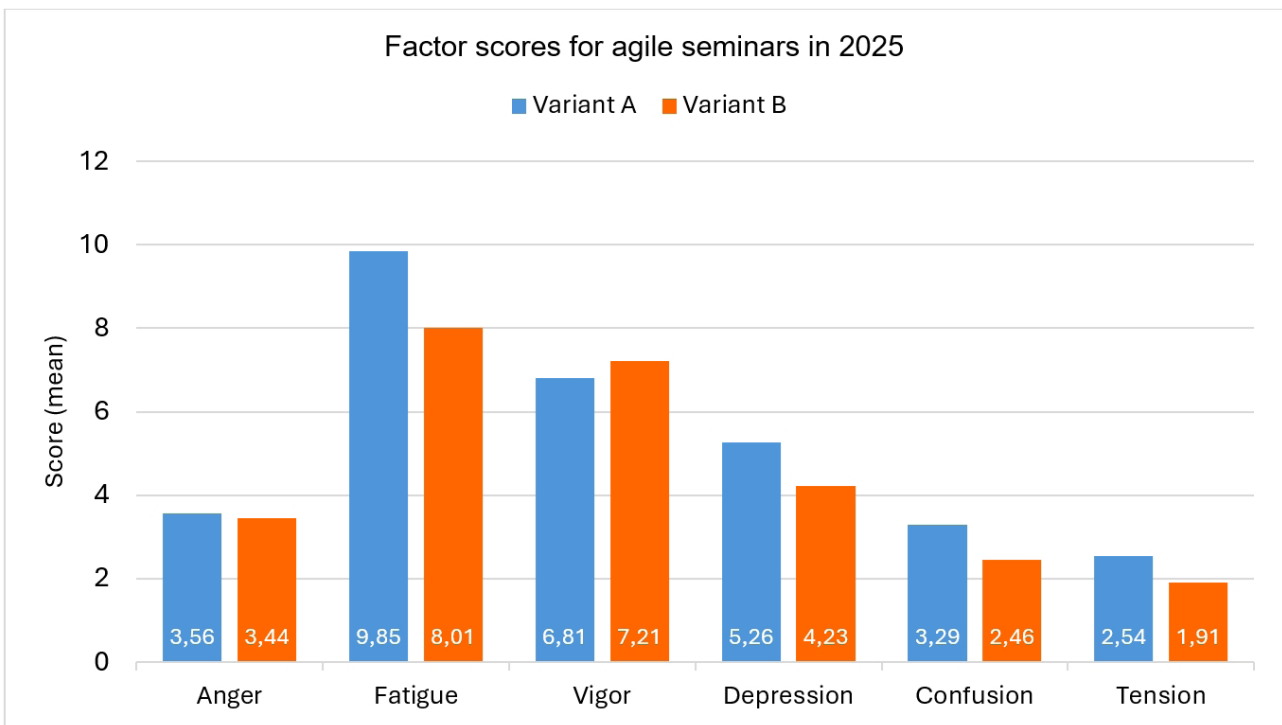


Figure 8: Factor scores for agile seminars in 2025. Source: own.

agile seminars. For H3 and the waterfall seminars, the changes in fatigue, depression, confusion, and tension were significant. The p -values of <0.001 for these four factors were below the threshold of 0.05, confirming H3₁ for these factors. The changes in anger and vigor were not significant, rejecting H3₁ for these two factors. For H4 and the agile seminars,

the changes in fatigue, depression, and confusion were significant. The p -values of <0.001 for these three factors were below the threshold of 0.05, confirming H4₁ for these factors. The changes in anger, vigor, and tension were not significant, rejecting H4₁ for these three factors. Further details for 2024 are presented in Table 4.

2024	factor	hypothesis	statistic	p-value	confirmed
Waterfall seminars	Anger	H3 ₁	1765.0	0.1432	no
	Fatigue		1230.5	< 0.001	yes
	Vigor		3769.0	0.3918	no
	Depression		1729.0	< 0.001	yes
	Confusion		1373.0	< 0.001	yes
	Tension		2150.0	< 0.001	yes
Agile seminars	Anger	H4 ₁	1811.5	0.7985	no
	Fatigue		2988.5	< 0.001	yes
	Vigor		2988.5	0.6095	no
	Depression		1305.0	< 0.001	yes
	Confusion		1077.0	< 0.001	yes
	Tension		1760.5	0.1001	no

Table 4: Statistical test results for factor changes between variants A and B in 2024. Source: own.

For 2025, we also found significant differences in factor scores for both seminar types. For H3 and the waterfall seminars, the changes in fatigue, depression, confusion, and tension were significant. The *p*-values of <0.001 for fatigue and confusion, 0.0098 for depression, and 0.0244 for tension were below the threshold of 0.05, confirming H3₁ for these factors. The changes in anger and vigor were not significant, rejecting H3₁.

for these two factors. For H4 and the agile seminars, the changes in fatigue, depression, confusion, and tension were significant. The *p*-values of <0.001 for fatigue and confusion, 0.0248 for depression, and 0.0480 for tension were below the threshold of 0.05, confirming H4₁ for these factors. The changes in anger and vigor were not significant, rejecting H4₁ for these two factors. Further details for 2025 are presented in Table 5.

2025	factor	hypothesis	statistic	p-value	confirmed
Waterfall seminars	Anger	H3 ₁	1354.5	0.2010	no
	Fatigue		835.5	< 0.001	yes
	Vigor		1868.0	0.5809	no
	Depression		1113.5	0.0098	yes
	Confusion		791.5	< 0.001	yes
	Tension		1187.5	0.0244	yes
Agile seminars	Anger	H4 ₁	1001.5	0.9643	no
	Fatigue		1020.0	< 0.001	yes
	Vigor		1655.0	0.5605	no
	Depression		915.5	0.0248	yes
	Confusion		600.0	< 0.001	yes
	Tension		799.0	0.0480	yes

Table 5: Statistical test results for factor changes between variants A and B in 2025. Source: own.

Based on the results of testing hypotheses H3 and H4, we can answer RQ2 as follows: most factors improved significantly during the practical project management seminars. Specifically, fatigue, depression, and confusion improved in both years and both seminar types.

DISCUSSION

We confirmed that participants' total mood and most individual factors improved during the seminars for both seminar types and all eligible years. These results indicate that our practical project management seminars had a positive effect on participants' mood, teamwork, and soft-skills practice. We compare all results and findings from the current research with the results of our prior research, discuss minor differences in seminar design between years, and address the limitations and implications of the research. Specifically, we compare results from our prior research using 2023 data ($n_{23} = 49$) with results from the current research using 2024 data ($n_{24} = 139$) and 2025

data ($n_{25} = 98$). Because our prior paper discussed the broader literature in detail, the present discussion focuses primarily on comparison across years, followed by a concise validation against related research.

Total mood changes during seminars

First, we discuss total mood changes during waterfall seminars. Figure 9 shows TMD scores during waterfall seminars for the years 2023–2025, in which we conducted the research. In the chart, the x-axis represents years, and the y-axis represents TMD scores. The bars represent TMD scores for the given years and seminar types, whereas the error bars represent the standard deviations for these scores. The chart shows that participants' total mood improved each year. The changes displayed in the chart are positive, which is why we refer to them as total mood improvements in the Results section. The resulting scores for waterfall seminars also show that participants' initial mood started with a worse score and ended

with a worse score than in the preceding year. For example, in 2023, the TMD score started at 121.50 and improved to 111.90.

Higher initial TMD scores correspond to poorer student mood states before the start of the seminars and management games.

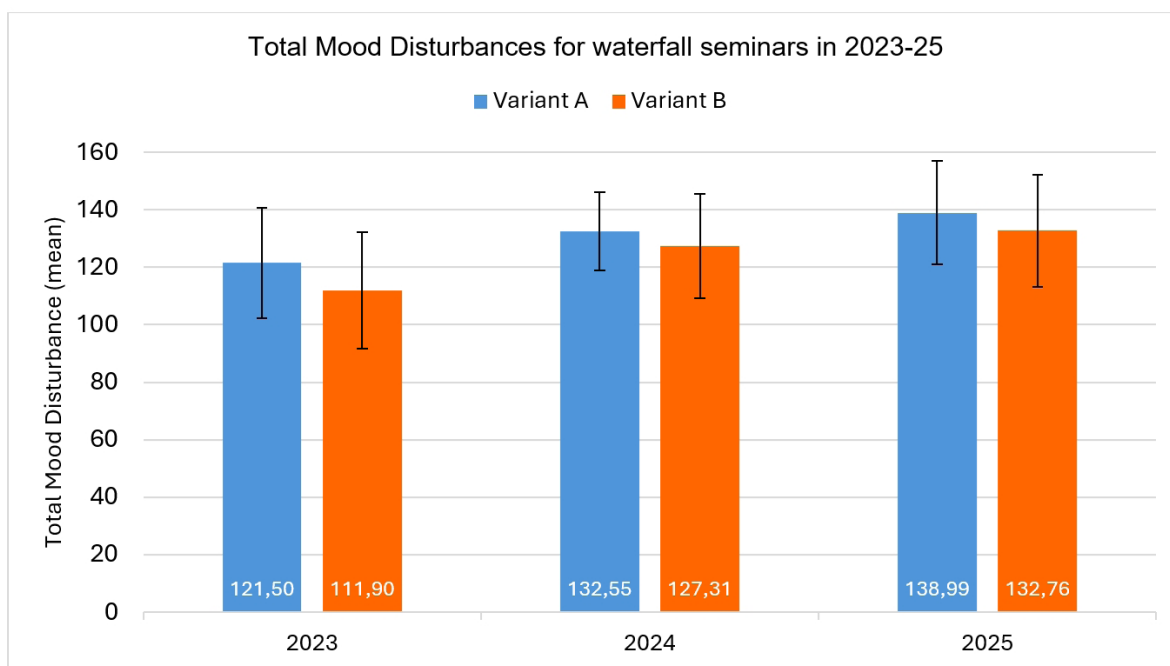


Figure 9: TMD scores for waterfall seminars in 2023-25. Source: own.

Second, we discuss total mood changes during agile seminars. Figure 10 shows TMD scores during agile seminars for the years 2023–2025. The chart presents TMD scores for these seminars. Changes in participants’ mood states are positive for all three years, which is consistent with waterfall seminars. However, differences are also visible. The initial TMD scores are nearly equal for 2023 (127.00) and 2024 (126.59) and slightly higher in 2025 (131.13). The final TMD scores

indicate differences between years similar to those observed for the waterfall seminars, i.e., the score is several points worse than in the previous year while still showing improvement. We also observed a larger improvement in 2023 (from 127.00 to 115.70), which may be related to the lower number of eligible participants in 2023 ($n_{23} = 49$) or to the change in the theme of agile management games from robots to amusement parks between 2023 and 2024.

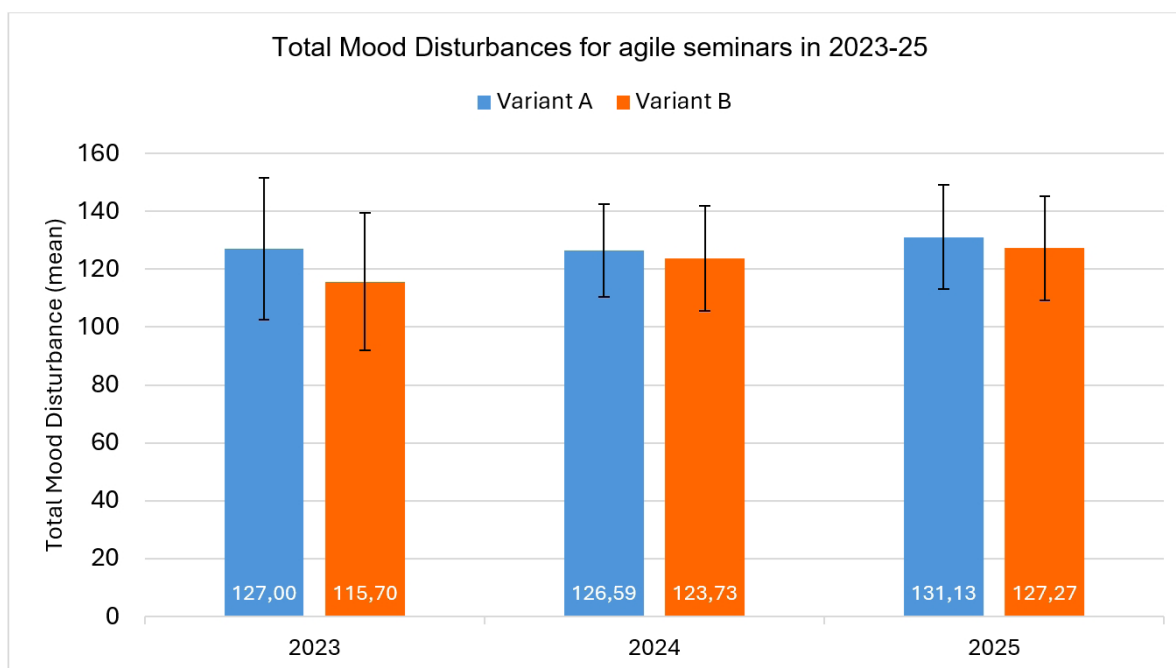


Figure 10: TMD scores for agile seminars in 2023–2025. Source: own.

Third, we discuss characteristics and hypotheses shared by both seminar types. The standard deviations are generally lower for both seminar types in 2024 and 2025 than in 2023. Lower standard

deviations indicate more consistent responses in the current years than in 2023. This difference may relate to the smaller data sample ($n_{23} = 49$) in 2023. Details are provided in Table 6.

		2023	2024	2025
Waterfall seminars	Variant A	19.12	13.52	17.89
	Variant B	20.33	18.14	19.54
Agile seminars	Variant A	24.52	16.04	17.94
	Variant B	23.78	18.17	18.09

Table 6: Comparison of Total Mood Disturbance standard deviations in 2023-25. Source: own.

From a statistical perspective, all described total mood improvements are statistically significant, as confirmed by hypotheses H1 and H2. Table 7 summarizes the hypothesis results, showing that both hypotheses were confirmed for both seminar types and all eligible years.

Based on this comparison of results, we can answer the final research question (RQ3): the results of participants' total mood improvement are consistent across the years 2023–2025, in which we conducted the seminars. Hence, our new findings and results from 2024–2025 fully support and reinforce our original findings from 2023.

	hypothesis	2023	2024	2025
Waterfall seminars	H1	confirmed	confirmed	confirmed
Agile seminars	H2	confirmed	confirmed	confirmed

Table 7: Comparison of the results of hypotheses H1 and H2.

Individual factor changes

Considering the factors, we examined only vigor and fatigue in prior research. We extended this investigation to all six factors in the current research using data from 2024 and 2025. For this reason, we can compare the results for vigor and fatigue across all years, whereas the remaining four factors can be compared only between 2024 and

2025. Table 8 compares the results of hypotheses H3₁ for waterfall seminars and H4₁ for agile seminars. Hypotheses H3₁ and H4₁ relate to individual factor improvements, which we tested separately for each factor. The table presents *p*-values for all individual factors and eligible years. Default color values indicate confirmed hypotheses, whereas bold values indicate rejected hypotheses.

2023-25	factor	hypothesis	2023	2024	2025
Waterfall seminars	Anger	H3 ₁	-	0.1432	0.2010
	Fatigue		<0.001	<0.001	<0.001
	Vigor		0.6021	0.3918	0.5809
	Depression		-	<0.001	0.0098
	Confusion		-	<0.001	<0.001
	Tension		-	<0.001	0.0244
Agile seminars	Anger	H4 ₁	-	0.7985	0.9643
	Fatigue		<0.001	<0.001	<0.001
	Vigor		0.0140	0.6095	0.5605
	Depression		-	<0.001	0.0248
	Confusion		-	<0.001	<0.001
	Tension		-	0.1001	0.0480

Table 8: Comparison of the results and *p*-values of hypotheses H3 and H4 for individual factor improvements in 2023-25. Source: own.

As shown in the table, most factors exhibit consistent results between years. For fatigue, we observed uniform results across all years and seminar types, with *p*-values of <0.001. Hence, all seminars significantly reduced participants' fatigue. For depression and confusion, we also observed consistent results for all combinations, with *p*-values below the threshold of 0.05. Similar to fatigue, all seminars decreased participants' depression and confusion. For tension, the results are consistent only for the waterfall seminars, with *p*-values below 0.05. The results for agile seminars are ambiguous. In 2024, H4₁ was rejected, whereas in 2025, H4₁ was confirmed with a *p*-value of 0.0480, which is close to the threshold of 0.05. For anger, we

observed consistent results for both years and seminar types, indicating no significant change in participants' anger during the seminars, with *p*-values above 0.05. Finally, for vigor, we observed consistent results except for the agile seminars in 2023. Most vigor results indicate no significant improvement, with *p*-values greater than 0.05. The exception may have been caused by the limited data sample in 2023. Table 8 presents *p*-values for all factors.

Validation in related research

Studies using the Profile of Mood States demonstrate that physical activity positively influences mood changes (Berger

and Motl, 2000). Multiple studies support this relationship. White et al. (2017) describe that practicing physical exercise is associated with improvements in mental health and mood, which is similar to our research outcomes. Results by Sahli et al. (2020) on soccer players also suggest that physical training positively influences students' physiological responses and creates positive psychological states. The impact of physical activity on mood is heightened by verbal encouragement from the teacher. Our findings extend these results to project management education, where practical seminars incorporating physical activities demonstrated positive effects on participant mood. Specifically, our results show improvements in soft-skills development and teamwork experience, consistent with this broader literature. Consistent with our outcomes, Reigal et al. (2021) demonstrated that moderate physical activity predicts better mood states and lower anxiety than vigorous activity, suggesting that our moderate-intensity management game approach aligns with optimal mood-enhancing parameters. Engaging in management games lowers participants' mood disturbance as well as fatigue and increases their total mood. Our results correspond to previous research by De Gloria et al. (2014) and Hellström et al. (2023), which shows that serious management games have positive motivational outcomes and offer convenient practical experience. Jaccard et al. (2022) demonstrated through a 10-year qualitative analysis that serious games trigger active pedagogies, develop soft-skill competencies, and transform teacher-student relationships.

The effectiveness of our approach is validated by comparable educational interventions using LEGO-based simulations. In a study by Paasivaara et al. (2014), students learned basic Scrum concepts using a LEGO-based simulation game, with participants reporting general satisfaction and significant learning outcomes. Barcelos Bica and Gouvea da Silva (2020) conducted a similar management game using LEGO blocks to build cities and concluded that students considered this activity highly effective and practical for learning Scrum. Both studies used an approach comparable to our agile seminars, in which participants constructed robots from LEGO components. The outcomes of both referenced papers correspond to the improvement in participants' total mood and vigor observed in our seminars, where improved vigor signifies higher energy, activity, and satisfaction. The importance of mood measurement extends beyond educational contexts. Pang et al. (2023) demonstrated through POMS measurement that positive mood profiles were associated with improved athletic performance, reinforcing the need to consider mood across diverse domains. In addition, Havazík and Pavlíčková (2020) found that the Scrum-based agile game helped the majority of students understand basic agile concepts. Miller and Vaca Núñez (2022) designed a management game to experience differences between waterfall and agile approaches and identified comparable imbalances in both methodologies. While traditional approaches emphasize extensive planning with fewer decisions, agile methods allow for faster initiation and more decisions throughout the game. Despite these differences, both seminar types showed comparable improvements in mood, demonstrating that management games are effective across different teaching approaches. Rumeser and Emsley

(2019) identified design principles supporting cross-contextual effectiveness, while Kesti et al. (2022) confirmed benefits across diverse settings. The research consistently supports the value of serious management games in learning contexts.

Practical implications and limitations

We maintained similar project requirements and working conditions for the practical seminars and management games between years to ensure research consistency. We made minor changes to the practical seminars as part of their continuous improvement. Since 2024, students have been building amusement parks instead of robots in agile seminars. The robot theme was a one-time event in 2023 and is no longer relevant. This change may have led to lower TMD scores for agile seminars, as discussed above. However, this difference could also be related to the limited data in the 2023 pilot research, since the results from 2024 and 2025 are consistent in this respect. Next year, we may either introduce a new topic or return to robots and observe the differences. We also simplified auxiliary work in the seminars, such as tracking work progress, to focus more on practical teamwork and soft skills. Regarding the research design, we no longer work with study groups. Study groups are not required for any research questions or comparisons between years.

Two main limitations of our research relate to the nature of the practical seminars and the scheduling of teaching at the faculty. First, we used two different management games for waterfall and agile seminars because students practise a different project management approach in each seminar type. Each approach involves different teamwork models, interactions, and skills. Second, to compare students' mood states during and between seminars, we required them to complete four questionnaires. We therefore had to eliminate all participants with fewer than four completed questionnaires from the datasets during data transformation. This requirement limited the questionnaire return rate. The return rate was therefore negatively affected by student absences, holidays, and various university events. In 2023, we arranged a limited study and collected data from 49 participants (a 49.5% return rate for eligible seminars). In 2024 and 2025, we extended our research to all students in the subject. In 2024, we collected data from 139 participants (a 51% return rate for all seminars). However, in 2025, we collected data from only 98 participants (a 30% return rate) because nearly half of the practical seminars were held on public or university holidays. Moreover, moving seminars to other weekdays is not an option because of other subjects that students attend. On the other hand, we addressed all limitations and suggestions for future research described in our previous research: we conducted a more detailed analysis of the factors, improved the seminars based on the results, and implemented a comprehensive software solution to support research design and data collection.

CONCLUSION

In 2023–2025, we organized practical waterfall and agile project management seminars each year for students in a project management course using serious management

games. We collected quantitative data on participants' mood states based on the Czech version of POMS. Our results for total mood improvement and for fatigue, depression, and confusion indicate a high level of consistency between years. We therefore verified and reinforced our previous findings regarding total mood improvement and fulfilled our research goal. In future research, we could extend this work to include diverse study groups and datasets beyond students at a single university in one project management subject and compare findings across these areas. We can focus on students at other universities, different languages, or employees training

in professional courses. We expect further development of the POMS Online software solution to better support multiple questionnaire types in different languages, which is essential for expanding the research. We could also integrate statistical functions in Python into the solution and introduce new functions.

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REFERENCES

- Axelos (2023) *Managing Successful Projects with PRINCE2*, London: The Stationery Office.
- Barcelos Bica, D. A. and Gouvea da Silva, C. A. (2020) 'Learning process of agile Scrum methodology with LEGO blocks in interactive academic games: Viewpoint of students', *IEEE Revista Iberoamericana de Tecnologias del Aprendizaje*, Vol. 15, No. 2, pp. 95–104. <https://doi.org/10.1109/RITA.2020.2987721>
- Bartoška, J. and Šubrt, T. (2012) 'The effect of human agent in project management', *Central European Journal of Operations Research*, Vol. 20, No. 3, pp. 369–382. <https://doi.org/10.1007/s10100-011-0209-4>
- Beck, K., Beedle, M., van Bennekum, A., Cockburn, A., Cunningham, W., Fowler, M., Grenning, J., Highsmith, J., Hunt, A., Jeffries, R., Kern, J., Marick, B., Martin, R. C., Mellor, S., Schwaber, K., Sutherland, J. and Thomas, D. (2001) *Manifesto for Agile Software Development*, Available at: <https://agilemanifesto.org/>
- Berger, B. G. and Motl, R. W. (2000) 'Exercise and mood: A selective review and synthesis of research employing the profile of mood states', *Journal of Applied Sport Psychology*, Vol. 12, No. 1, pp. 69–92. <https://doi.org/10.1080/10413200008404214>
- Bourgeois, A. E., LeUnes, A. and Meyers, M. C. (2010) 'Full-scale and short-form of the Profile of Mood States: A factor analytic comparison.', *Journal of Sport Behavior*, vol. 33, no. 4, pp. 355–376. Available at: https://www.researchgate.net/profile/Michael-Meyers-2/publication/285735992_Full-scale_and_short-form_of_the_profile_of_mood_states_A_factor_analytic_comparison/links/60ac0b3692851ca9dce1d947/Full-scale-and-short-form-of-the-profile-of-mood-states-A-factor-analytic-comparison.pdf
- Boyle, G. J., Helmes, E., Matthews, G. and IZard, C. E. (2015) 'Measures of affect dimensions', in: *Measures of Personality and Social Psychological Constructs*, London: Elsevier, pp. 190–224. <https://doi.org/10.1016/B978-0-12-386915-9.00008-5>
- Branzei, R., Ferrari, G., Fragnelli, V. and Tijs, S. (2011) 'A bonus-malus approach to project management', *Central European Journal of Operations Research*, Vol. 19, No. 4, pp. 495–512. <https://doi.org/10.1007/s10100-010-0139-6>
- Chow, T. and Cao, D.-B. (2008) 'A survey study of critical success factors in agile software projects', *Journal of Systems and Software*, Vol. 81, No. 6, pp. 961–971. <https://doi.org/10.1016/j.jss.2007.08.020>
- Ciric, D., Lalic, B., Gracanin, D., Tasic, N., Delic, M. and Medic, N. (2019) 'Agile vs. Traditional Approach in Project Management: Strategies, Challenges and Reasons to Introduce Agile', *Procedia Manufacturing*, Vol. 39, pp. 1407–1414. <https://doi.org/10.1016/j.promfg.2020.01.314>
- Curran, S. L., Andrykowski, M. A. and Studts, J. L. (1995) 'Short Form of the Profile of Mood States (POMS-SF): Psychometric information', *Psychological Assessment*, Vol. 7, No. 1, pp. 80–83. <https://doi.org/10.1037/1040-3590.7.1.80>
- De Gloria, A., Bellotti, F. and Berta, R. (2014) 'Serious Games for education and training', *International Journal of Serious Games*, Vol. 1, No. 1. <https://doi.org/10.17083/ijsg.v1i1.11>
- Digital.ai (2024) *17th State of Agile Report: Analyst Reports*, Available at: <https://digital.ai/resource-center/analyst-reports/state-of-agile-report/>
- Dingsøy, T., Nerur, S., Balijepally, V. and Moe, N. B. (2012) 'A decade of agile methodologies: Towards explaining agile software development', *Journal of Systems and Software*, Vol. 85, No. 6, pp. 1213–1221. <https://doi.org/10.1016/j.jss.2012.02.033>
- Djaouti, D., Alvarez, J. and Jessel, J.-P. (2011) 'Classifying serious games: The G/P/S model', in: *Handbook of Research on Improving Learning and Motivation through Educational Games*, Hershey, PA: IGI Global, pp. 118–136. <https://doi.org/10.4018/978-1-60960-495-0.ch006>
- Fernandes, S., Dinis-Carvalho, J. and Ferreira-Oliveira, A. T. (2021) 'Improving the Performance of Student Teams in Project-Based Learning with Scrum', *Education Sciences*, Vol. 11, No. 8, p. 444. <https://doi.org/10.3390/educsci11080444>
- Hankiewicz, K. and Weber, G.-W. (2020) 'Human factors in a contemporary organization', *Central European Journal of Operations Research*, Vol. 28, No. 2, pp. 1–5. <https://doi.org/10.1007/s10100-020-00676-8>
- Havazik, O. and Pavlíčková, P. (2020) 'Using a simulation game in the education of an agile approach', in: *Proceedings of the 17th International Conference on Efficiency and Responsibility in Education and Science (ERIE 2020)*, Prague, pp. 76–82.
- Heikura, E. E., Aunola, K., Tolvanen, A., Ryba, T. V. and Selänne, H. (2023) 'Student-athletes' mood state profiles: the role of sports, sex, and performance level in sports and in school', *Journal of Applied Sport Psychology*, Vol. 35, No. 5, pp. 836–853. <https://doi.org/10.1080/10413200.2022.2158250>
- Hellström, M. M., Jaccard, D. and Bonnier, K. E. (2023) 'Systematic review on the use of serious games in project management education', *International Journal of Serious Games*, Vol. 10, No. 2, pp. 3–24. <https://doi.org/10.17083/ijsg.v10i2.630>
- Heuchert, J. P. and McNair, D. M. (2012) Profile of Mood States 2nd Edition™ [Dataset], *PsycTESTS*. Washington, DC: American Psychological Association. <https://doi.org/10.1037/t05057-000>
- Hobbs, B. and Petit, Y. (2017) 'Agile Methods on Large Projects in Large Organizations', *Project Management Journal*, Vol. 48, No. 3, pp. 3–19. <https://doi.org/10.1177/875697281704800301>

- Horáček, J. (2025) 'Modeling dynamics of opinion formation in small groups: A framework capturing individual opinion adjustments', *Central European Journal of Operations Research*, Vol. 33, No. 3, pp. 729–756. <https://doi.org/10.1007/s10100-025-00982-z>
- Hron, M. and Obwegeser, N. (2022) 'Why and how is Scrum being adapted in practice: A systematic review', *Journal of Systems and Software*, Vol. 183, p. 111110. <https://doi.org/10.1016/j.jss.2021.111110>
- Jaccard, D., Bonnier, K. E. and Hellström, M. (2022) 'How might serious games trigger a transformation in project management education? Lessons learned from 10 Years of experimentations', *Project Leadership and Society*, Vol. 3, p. 100047. <https://doi.org/10.1016/j.plas.2022.100047>
- Johnson, C. D., Beebe, A. Z., Eagle, S. R., Mi, Q., Lovalekar, M. T., Pepping, G.-J., et al. (2019) 'Profiles of mood state fatigue scale is responsive to fatiguing protocol but shows no relationship to perceived or performance decrements', *Translational Sports Medicine*, Vol. 2, No. 3, pp. 153–160. <https://doi.org/10.1002/tsm2.65>
- Jones, M. T., Matthews, T. D., Murray, M., Van Raalte, J. and Jensen, B. E. (2010) 'Psychological correlates of performance in female athletes during a 12-week off-season strength and conditioning program', *Journal of Strength and Conditioning Research*, Vol. 24, No. 3, pp. 619–628. <https://doi.org/10.1519/JSC.0b013e3181cc23c3>
- Kesti, M., Ylitalo, A.-I. and Vakkala, H. (2022) 'Management game: Gamifying leadership learning', in: *Research Anthology on Human Resource Practices for the Modern Workforce*, Hershey, PA: IGI Global, pp. 1783–1799. <https://doi.org/10.4018/978-1-6684-3873-2.ch090>
- Kunhart, J. (2025) 'POMS Online: Softwarové řešení pro sledování změn nálad studentů', in: *Informatika 2025*, pp. 32–38.
- Kunhart, J. and Bartoška, J. (2025) 'Mood States as a Key Factor in Assessing Student Learning in Project Management Teaching', *Journal on Efficiency and Responsibility in Education and Science*, Vol. 18, No. 2, pp. 78–90. <https://doi.org/10.7160/eriesj.2025.180202>
- Likert, R. (1932) 'A technique for the measurement of attitudes', *Archives of Psychology*, Vol. 22, No. 140, pp. 1–55.
- McNair, D. M., Lorr, M. and Droppleman, L. F. (1971) *Manual for the Profile of Mood States*, San Diego, CA: Educational and Industrial Testing Service.
- Miller, G. and Vaca Núñez, V. (2022) 'The Project Win Game™: A Serious Game for Project Management Simulation', *European Conference on Games Based Learning*, Vol. 16, No. 1, pp. 358–367. <https://doi.org/10.34190/ecgbl.16.1.660>
- Özbey, M. F. and Turhan, C. (2025) 'Modelling the positive and negative interaction between mood and thermal sensation in the built environment using a combined Markov Chain Monte Carlo algorithm and Morris method', *Building Services Engineering Research & Technology*, Vol. 46, No. 6, pp. 737–752. <https://doi.org/10.1177/01436244251346640>
- Paasivaara, M. and Lassenius, C. (2014) 'Communities of practice in a large distributed agile software development organization – Case Ericsson', *Information and Software Technology*, Vol. 56, No. 12, pp. 1556–1577. <https://doi.org/10.1016/j.infsof.2014.06.008>
- Paasivaara, M., Heikkilä, V., Lassenius, C. and Toivola, T. (2014) 'Teaching students Scrum using LEGO blocks', in: *Companion Proceedings of the 36th International Conference on Software Engineering (ICSE Companion 2014)*, pp. 382–391. <https://doi.org/10.1145/2591062.2591169>
- Pang, L., Xie, X. and Lin, Y. (2023) 'POMS and eye movement: Two indicators for performance in athletics', *Heliyon*, Vol. 9, No. 7, p. e17860. <https://doi.org/10.1016/j.heliyon.2023.e17860>
- Petrowski, K., Bjelopavlovic, M., Zenger, M., Brähler, E. and Schmalbach, B. (2025) 'Psychometric properties and norm values of a short screening version of the profile of mood states POMS from the German general population', *Scientific Reports*, Vol. 15, No. 1. <https://doi.org/10.1038/s41598-025-07388-6>
- Project Management Institute (2026) *A Guide to the Project Management Body of Knowledge (PMBOK® Guide) – Eighth Edition and The Standard for Project Management*, Newtown Square, PA: Project Management Institute.
- Prasetya, K. D., Suharjito and Pratama, D. (2021) 'Effectiveness analysis of distributed Scrum model compared to Waterfall approach in third-party application development', *Procedia Computer Science*, Vol. 179, pp. 103–111. <https://doi.org/10.1016/j.procs.2021.12.014>
- Reigal, R. E., Páez-Maldonado, J. A., Pastrana-Brincones, J. L., Morillo-Baro, J. P., Hernández-Mendo, A. and Morales-Sánchez, V. (2021) 'Physical Activity Is Related to Mood States, Anxiety State and Self-Rated Health in COVID-19 Lockdown', *Sustainability*, Vol. 13, No. 10, p. 5444. <https://doi.org/10.3390/su13105444>
- Royce, W. W. (1987) 'Managing the development of large software systems: Concepts and techniques', in: *Proceedings of the 9th International Conference on Software Engineering*, Monterey, CA: IEEE Computer Society Press, pp. 328–338.
- Rumeser, D. and Emsley, M. (2019) 'Lessons learned from implementing project management games', *International Journal of Serious Games*, Vol. 6, No. 1, pp. 71–92. <https://doi.org/10.17083/ijsg.v6i1.130>
- Sahli, H., Selmi, O., Zghibi, M., Hill, L., Rosemann, T., Knechtel, B. and Clemente, F. M. (2020) 'Effect of the verbal encouragement on psychophysiological and affective responses during small-sided games', *International Journal of Environmental Research and Public Health*, Vol. 17, No. 23, p. 8884. <https://doi.org/10.3390/ijerph17238884>
- Searight, H. R. and Montone, K. (2017) 'Profile of mood states', in: Zeigler-Hill, V. and Shackelford, T. K. (eds.), *Encyclopedia of Personality and Individual Differences*, Cham: Springer International Publishing, pp. 1–6. https://doi.org/10.1007/978-3-319-28099-8_63-1
- Shacham, S. (1983) 'A Shortened Version of the Profile of Mood States', *Journal of Personality Assessment*, Vol. 47, No. 3, pp. 305–306. https://doi.org/10.1207/s15327752jpa4703_14
- Schwaber, K. and Sutherland, J. (2012) *The Scrum Guide*, Available at: <https://scrumguides.org/docs/scrumguide/v1/Scrum-Guide-US.pdf>
- Shore, J. (2021) *The Art of Agile Development*, 2nd edn, Sebastopol, CA: O'Reilly Media.
- Spielberger, C. D. (1972) 'Review of Profile of Mood States', *Professional Psychology*, Vol. 3, No. 4, pp. 387–388. <https://doi.org/10.1037/h0020742>
- Stuchlíková, I., Man, F. and Hagtvet, K. (2005) 'Dotazník k měření afektivních stavů: Konfirmační faktorová analýza krátké české verze', *Československá psychologie*, Vol. 49, No. 5, pp. 459–469.
- Sutherland, J. (2014) *Scrum: The Art of Doing Twice the Work in Half the Time*, New York: Currency.
- White, R. L., Babic, M. J., Parker, P. D., Lubans, D. R., Astell-Burt, T. and Lonsdale, C. (2017) 'Domain-Specific Physical Activity and Mental Health: A Meta-analysis', *American Journal of Preventive Medicine*, Vol. 52, No. 5, pp. 653–666. <https://doi.org/10.1016/j.amepre.2016.12.008>
- Wilcoxon, F. (1945) 'Individual Comparisons by Ranking Methods', *Biometrics Bulletin*, Vol. 1, No. 6, pp. 80. <https://doi.org/10.2307/3001968>
- Young Illies, M. and Stachowski, A. A. (2020) 'Improving students' teamwork experience: Evaluating a project management application', *Scholarship of Teaching and Learning in Psychology*, Vol. 6, No. 1, pp. 46–52. <https://doi.org/10.1037/stl0000155>

APPENDIX A LIST OF PROFILE OF MOOD STATES ADJECTIVES (QUESTIONS)

Czech adjectives are not always exact translations of the original terms. For several adjectives, the authors selected and attested more suitable Czech alternatives.

Question identifier	Czech adjective (question)	English adjective (question)
1	Napjatý	Tense
2	Vzteklý	Angry
3	Opotřebovaný	Worn out
4	Nešťastný	Unhappy
5	Plný života	Lively
6	Zmatený	Confused
7	Nevrlý	Grumpy
8	Smutný	Sad
9	Energický	Energetic
10	Rozrušený	On edge
11	Naštvaný	Grouchy
12	Sklíčený	Ashamed
13	Rázný	Active
14	Bez naděje	Hopeless
15	Nepříjemný	Uneasy
16	Neklidný	Restless
17	Neschopen se soustředit	Unconcentrated
18	Unavený	Fatigued
19	Rozzlobený	Annoyed
20	Malomyslný	Discouraged
21	Podrážděný	Resentful
22	Nervózní	Nervous
23	Mizerný	Miserable
24	Veselý	Cheerful
25	Rozhořčený	Bitter
26	Vyčerpaný	Exhausted
27	Úzkostný	Anxious
28	Zoufalý	Helpless
29	Utahaný	Weary
30	Popletený	Bewildered
31	Rohněvaný	Furious
32	Plný elánu	Full of pep
33	Zbytečný	Worthless
34	Roztržitý	Forgetful
35	Činorodý	Vigorous
36	Nejistý	Uncertain
37	Přetažený	Bushed

Table 9: List of adjectives in the Czech version of the Profile of Mood States questionnaire. Source: Stuchlíková et al. (2005).

APPENDIX B

2024	factor	n	mean	std dev	var	min	max	
Waterfall seminars	Variant A	Anger	139	2.8489	3.8082	14.6074	0	24
		Fatigue	139	10.1799	5.4684	30.1196	0	23
		Vigor	139	9.3813	4.6308	21.5999	0	24
		Depression	139	3.8993	3.8911	15.2507	0	18
		Confusion	139	3.4532	2.6586	7.1192	0	14
	Tension	139	2.7914	2.2424	5.0649	0	11	
	Variant B	Anger	139	2.7338	4.7613	22.8344	0	24
		Fatigue	139	7.0000	5.9772	35.9855	0	24
		Vigor	139	9.8993	4.8744	23.9318	0	24
		Depression	139	3.1583	5.3095	28.3951	0	28
Confusion		139	2.2734	3.2093	10.3740	0	16	
Agile seminars	Variant A	Tension	139	2.4460	2.5356	6.4760	0	12
		Anger	139	2.2878	3.6742	13.5977	0	18
		Fatigue	139	8.0647	5.8460	34.4233	0	22
		Vigor	139	8.2446	5.3062	28.3600	0	24
		Depression	139	3.4460	4.2361	18.0750	0	23
	Variant B	Confusion	139	2.5108	2.7520	7.6285	0	11
		Tension	139	2.0360	2.1337	4.5857	0	11
		Anger	139	2.5036	4.5223	20.5996	0	24
		Fatigue	139	6.7194	6.2433	39.2613	0	24
		Vigor	139	8.3957	5.4728	30.1684	0	24
Variant B	Depression	139	2.6259	4.6693	21.9605	0	28	
	Confusion	139	1.6835	2.7564	7.6527	0	16	
	Tension	139	1.7986	2.4715	7.6527	0	12	

Table 10: Descriptive statistics for individual factor scores between variants A and B in 2024. Source: own.

2025	factor	n	mean	std dev	var	min	max	
Waterfall seminars	Variant A	Anger	98	5.0000	4.7552	22.8454	0	20
		Fatigue	98	12.0816	5.9310	35.5397	1	24
		Vigor	98	8.8469	4.6541	21.8835	0	20
		Depression	98	5.8673	4.6744	22.0750	0	23
		Confusion	98	4.1122	3.0636	9.4821	0	14
	Variant B	Tension	98	3.0816	2.5582	6.6118	0	12
		Anger	98	4.2857	4.9672	24.9278	0	24
		Fatigue	98	9.0918	6.0695	37.2183	0	24
		Vigor	98	8.8265	4.7359	22.603	0	21
		Depression	98	4.9286	5.3251	28.5412	0	25
Agile seminars	Variant A	Confusion	98	3.0816	3.1773	10.1995	0	15
		Tension	98	2.5408	2.4751	6.1890	0	12
		Anger	98	3.5612	4.5267	20.7024	0	20
		Fatigue	98	9.8469	6.8308	47.1413	0	24
		Vigor	98	6.8163	4.1240	17.1824	0	20
	Variant B	Depression	98	5.2551	5.0494	25.7590	0	22
		Confusion	98	3.2857	3.0739	9.5464	0	13
		Tension	98	2.3673	2.2830	5.2657	0	9
		Anger	98	3.4388	4.4264	19.7952	0	21
		Fatigue	98	8.0102	6.2979	40.0721	0	24
Variant B	Vigor	98	7.2143	4.4841	20.3144	0	19	
	Depression	98	4.2347	5.0725	25.9959	0	21	
	Confusion	98	2.4592	2.9869	9.0138	0	12	
Variant B	Tension	98	1.9082	2.0308	4.1667	0	9	

Table 11: Descriptive statistics for individual factor scores between variants A and B in 2025. Source: own.