MOOD STATES AS A KEY FACTOR IN ASSESSING STUDENT LEARNING IN PROJECT MANAGEMENT TEACHING

Josef Kunhart✉
Jan Bartoška

Faculty of Economics and Management, Czech University of Life Sciences Prague, Czech Republic

✉ kunhart@pef.czu.cz

ABSTRACT

Hands-on experience is an essential part of project management education. We researched to determine whether our practical seminars organized as part of an undergraduate project management course provide the expected learning experience consistent with current project management practice. We organized two practical seminars for students in four study groups that utilized serious management games. The seminars focused on traditional and agile project management, emphasizing the differences in teamwork and emotional states of the participants between both approaches. We used the Profile of Mood States psychological method to evaluate the total mood changes of eligible participants ($n = 49$). We found that respondents' total mood and fatigue have improved significantly during practical seminars, confirming that serious management games have a positive effect on student learning and experience. We observed no significant difference in total mood improvement between traditional and agile seminars. We learned that the vigor of the participants has increased only for the agile seminars. This outcome is consistent with actual research and empirical experience in the field. The study results will be used to improve the quality of practical seminars next year.

KEYWORDS

HOW TO CITE

Highlights

- *We organized traditional and agile project management seminars that utilized practical, serious management games to encourage teamwork and learning soft skills.*
- *The total mood of the participants has improved in both traditional and agile project management seminars.*
- *The vigor of the participants has increased only for the agile project management seminars.*
- *Fatigue of the participants has decreased for both traditional and agile seminars.*

INTRODUCTION

Project Management

Project management is 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). Project management can also be viewed as a change management process where organizations and individuals use limited resources to implement projects to create unique products, services, or results. Project teams achieve the outcomes using multiple techniques, such as traditional and agile project management. Traditional project management utilizes waterfall methods to manage projects, while agile project management employs agile methods (PMI, 2021). Traditional project management focuses on planning ahead and a carefully prepared project plan. Project

Management Body of Knowledge (PMBOK) divides projects into five phases: initiating, planning, executing, monitoring and controlling, and closing the project (PMI, 2021). Waterfall methods require upfront project design and allow only limited feedback and changes between each project phase. In addition, waterfall methods rely heavily on project outcome controls instead of fast feedback (Mahadevan, 2015).

Agile software development is a modern approach to managing software projects that emerged as a response to the software development crisis in the 90s (Shore, 2021) and a different way to develop software (Chow and Cao, 2008). In contrast to traditional project management methods that focus on planning and a precisely assembled project plan (PMI, 2021), agile software development methods focus on the incremental delivery of business value in short cycles. Agile approaches embrace change, innovations, and immediate feedback from

the customer. Manifesto for Agile Software Development (Beck et al., 2001) declares four fundamental values and twelve principles of agile software development as agreed upon by a collective of software engineering professionals. Highsmith (2010) and Niewöhner et al. (2019) pointed out that agile software development methods excel at innovative and start-up software projects. The Scrum method is the most utilized agile framework (Digital.ai, 2024) that largely dominates actual agile software development practices (Kadenic et al., 2023).

Scrum and Agile Adoption

Scrum is a collaborative software development method and framework that emerged to develop complex systems in dynamically changing environments (Schwaber and Sutherland, 2012). Scrum is a flexible and adaptive framework that is convenient for delivering innovations and prototyping new solutions. Scrum is heavily influenced by previous methodologies employed in manufacturing (Sutherland, 2014), most notably Lean production and Toyota Production System (Liker and Ross, 2017). Scrum defines fixed-time iterations as sprints, team roles, events, and artifacts (Schwaber and Sutherland, 2012). Scrum is considered a highly effective and productive method to manage and improve projects in software companies (Guerrero-Calvache and Hernández, 2023). Scrum emerged as a new way to develop software (Chow and Cao, 2008) that is nowadays widely adopted both in software engineering and development (Paasivaara and Lassenius, 2014; Hobbs and Petit, 2017) and a wide range of other settings and purposes in- and outside of the traditional project management context (Hron and Obwegeser, 2022).

Most organizations are adapting to agile methodology practice, as it helps accommodate ad-hoc business requirements and enhances team collaboration and customer experience. For better business value for the customer, the best option is to choose an agile method for managing the project (Roshan and Santhosh, 2021). Scrum adoption conveys improved teamwork, team communication, and performance. These benefits are related to agile principles (Beck et al., 2001) and Scrum values (Schwaber and Sutherland, 2012). Scrum and agile approaches provide many advantages over traditional approaches. Azanha et al. (2017) claimed that Scrum proved to be a viable option for managing a project. Based on the results of the implemented project, Scrum reduced the development time by 75% compared to traditional methods. In a study conducted by Bianchi et al. (2020), the use of the agile approach and sprints is positively related to product quality and on-time and on-budget completion, unlike the plan-driven Stage-Gate models that the authors compared to agile methods.

Agile software development is based on a gradual, repeated approach that focuses on flexibility, acceptability of change, continuous advancement, and strong interaction (Ciric et al., 2019). Agile methodologies emphasize the team members' interactions as opposed to rigid traditional software development. Therefore, agile software development methods such as Scrum should consider team members' affective states since these influence agile project activities (Salido et al., 2023). Observed moods include both positive and negative moods, such as general emotions, happiness, joy, stress, confusion, and anger. Additional benefits related to the utilization of the Scrum method include increased motivation and staff satisfaction, better control of requirements, and higher quality of delivered system and value (Azanha et al., 2017). According to Malik et al. (2021), agile team autonomy and communication practices contributed to improved team mood. This psychological empowerment led to the innovative behavior of agile teams that positively affects project performance. As suggested by Maynard et al. (2012), behavior that delivers innovative outcomes has also been shown to be a consequence of psychological empowerment.

Serious Management Games

Practical experience is an essential part of education for students who consider future careers in project management. Active learning in project management focuses on teamwork, cooperation, and project conducting with the help of serious management games and simulations. Serious management games positively impact learning skills that are difficult to improve through traditional education (Paasivaara et al., 2014; Kesti et al., 2022; Hellström et al., 2023). A serious game is specially designed for educational purposes, not just pure entertainment (Djaouti et al., 2011). Project management serious games are chiefly used for educational purposes to develop soft skills. Serious management games enable the development and acquisition of soft skills and work in a risk-free environment that encourages experimenting (Hellström et al., 2023). The important aspects of successful management games are game realism and context, feedback, adaptation to the target audience, communication, and personalization. The main beneficiaries of the games include students, educators, and trainers (Rumeser and Emsley, 2019). Project management games tend to involve hands-on building activities and simulations. Building activities utilize LEGO blocks or similar building kits for teaching agile principles and Scrum (Barcelos Bica and Gouvea da Silva, 2020; Paasivaara et al., 2014). Simulation games utilize common tools, such as pencils, crayons, and papers, to help students understand basic concepts of agile project management approaches (Havazík and Pavlíčková, 2020) or software applications to simulate complex activities behind the scenes, such as management behavior for learning leadership principles, suggested by Kesti et al. (2022). The Project Win Game by Miller and Vaca Núñez (2022) encourages the participants to experience the differences between traditional and agile approaches.

Research Objectives

The research goal is to determine whether the serious management games conducted in our practical seminars provide the expected learning experience consistent with current practical project management practice in organizations that use the Scrum method for managing projects. Specifically, the seminars improve students' moods, and agile practical seminars positively impact team members' energy, work effort, and performance. From the psychological perspective of the Profile of Mood States (POMS) method, the total mood of the participants is represented by their total mood state, while high energy is related to increased vigor and low energy is related to increased fatigue of the participants

(McNair et al., 1971; Stuchlíková et al., 2005). During the initial part of our research, we conducted a systematic literature review in the scientific databases Web of Science, Scopus, and APA PsycNet. We searched for papers focusing on the POMS method, traditional and agile project management in education, practical experience and teamwork, and serious management games. According to the scientific databases, we have not found any studies that directly utilize POMS in either project management education or professional practice, which constitutes a research gap for our research. Regarding education and teamwork, we found that most scholarly articles focus on evaluating sports performance, not project management.

Therefore, we formulate research questions that address the research goal and gap:

- RQ1: Has the total mood of participants improved during the traditional and agile project management seminars?
- RQ2: Is there a significant difference in total mood change between the traditional and agile project management seminars?
- RQ3: Is there a difference in vigor changes between traditional and agile project management seminars?
- RQ4: Is there a difference in fatigue changes between traditional and agile project management seminars?

The paper is organized as follows: In materials and methods, we describe the design of seminars, the questionnaire survey used to collect data, and the statistical analysis of the data. We present results for total mood improvement, vigor, and fatigue. In discussion, we review and compare our results with those of authors in the same research areas and discuss the limitations of our research. In conclusion, we summarize the paper and propose possibilities for future research.

MATERIALS AND METHODS

Practical Project Management Seminars

We arranged two practical project management seminars for the students of the Planning and Project Management undergraduate course. The seminars evaluated included four study groups, adding up to eight individual seminars. The activities in the seminars included teamwork, soft skills practice, and physical activities, such as the students constructing paper castles and assembling robots to gain first-hand experience in project management. For the majority of participants, the seminars represented the first practical experience in the field. We compared teamwork between traditional and agile project management methods in the seminars. Each method is suitable for a different kind of project and addresses different teamwork models, emotional states, and interactions in the team. Hence, we arranged one traditional and one agile project management seminar for every study group. The seminars took place in November and December 2023 at the Faculty of Economics and Management of the Czech University of Life Sciences Prague (FEM CULS) and focused on practical traditional and agile project management experience with the help of serious management games. We posed equal requirements and arranged equal working conditions for all participants regardless of study group.

We aimed to observe and evaluate shifts in participants' mood states between starting and finishing the management game at each seminar and traditional and agile project management seminars. Therefore, we requested the participants to answer a pair of online questionnaires at each seminar. Before delivering the questionnaire forms to the participants, we informed them about the research and its main purpose, which was to improve the quality of teaching at the practical project management seminars. We told the participants that we would collect e-mail addresses, and the collected e-mail addresses would be anonymized and serve as unique identifiers for connecting the responses between the seminars and questionnaire variants. We have not collected any additional personal data, such as name, surname, age, or gender. Participation in the research was voluntary; the participants consented to processing their e-mail addresses. For the details, see the questionnaire survey and data processing sections.

At the beginning of each seminar, we introduced and explained the task for that seminar to the participants. The respondents filled in the first form after introducing the task, before starting the serious management game. The respondents filled in the second form at the end of the seminar after completing the task and presenting their work to their colleagues. We collected quantitative primary data via these questionnaire forms. Following the data collection and analysis, we removed ineligible responses, mostly due to absences in one or both practical seminars. Hence, we worked with eligible respondents ($n = 49$) who participated in both seminars and filled in all four questionnaires. Finally, we formulated hypotheses that serious management games improve participants' mood and that this effect is more significant for agile project management methods than traditional project management methods.

PROFILE OF MOOD STATES

Profile of Mood States (POMS) is a psychological method and rating scale for measuring and assessing changes in the participants' mood states. McNair et al. (1971) introduced this method to quickly and efficiently evaluate changes in the participants' mood state. During an observed activity (called intervention), the participants fill in a pair of paper or online questionnaires (called variants) before and after the assessed activity. Multiple interventions are ordinarily used to assess mood change over time (Jones et al., 2010). The questionnaire utilizes a list of questions, including adjectives describing the respondent's mood state and a five-point Likert scale (Likert, 1932) for answers. The scale includes five answers: not at all, a little, moderately, quite a lot, extremely. Most answers are encoded as integer values from 0 to 4 (with few exceptions encoded from 4 to 0). The original version of the questionnaire contains 65 questions that aggregate six dimensions (factors) of mood shifts. The aggregated dimensions include anger/hostility, fatigue/inertia, vigor/activity, depression/dejection, confusion/bewilderment, and tension/anxiety.

In the following text, we will refer to these dimensions as factors and use only the first term for each factor, i.e., anger. The partial score for each dimension is calculated from the associated mood state values. Total Mood Disturbance (TMD) is calculated by adding the tension, depression, anger,

fatigue, and confusion scores and then subtracting the vigor ("vigour" in the original paper) score (McNair et al., 1971).

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

See formula 1 for the equation for calculating the TMD. Scoring instructions and formulas are an integral part of POMS. A constant of 100 is added to the TMD score to eliminate negative scores (Sahli et al., 2020). Higher TMD scores indicate greater mood disturbance and, thus, more negative mood.

Subsequently, Shacham (1983) introduced a short version of the POMS questionnaire to address the drawbacks of the original version, especially the excessive form length. The short form includes 37 questions that derive from the original list of questions while preserving the accuracy and reliability of the long questionnaire. In 2012, McNair and Heuchert introduced a revised version of the original method called POMS 2 (Heuchert and McNair, 2012). The revised form includes an additional friendliness factor (dimension) and many normative changes. The main disadvantage of POMS 2 is the lack of scoring instructions and scoring key. The results must be evaluated exclusively using the publisher's online tool (Boyle et al., 2015). This applies to both online and paper questionnaires. The POMS method is primarily utilized for evaluating mood changes related to sports, such as athletics (Heikura et al., 2023) or swimming (Chennaou et al., 2016). White et al. (2017) point out that physical activity positively correlates with improvements in participants' mental health and mood states. In a systematic literature review, Berger and Motl (2000) state that many studies support a positive relationship between physical exercise and mood changes. Therefore, POMS is a suitable tool for evaluating teamwork and physical activities during serious management games and sports performances.

Since its introduction in 1971, the Profile of Mood States method has been adapted to more than 42 different languages (Boyle et al., 2015). The Czech version of the form is designed and verified for Czech audiences and their habits. This adaptation of the questionnaire contains 37 questions tailored for the Czech audience. Multiple questions in the Czech questionnaire differ from the direct translations of the questions included in the original POMS variants. Calculating the TMD in the Czech version of the questionnaire utilizes the same formula as the original version of POMS (see Figure 1). In addition, calculations of partial scores for each dimension have been altered to reflect the list of mood states available in the Czech version. In the seminars, we utilized the Profile of the Mood States psychological method as an appropriate tool for evaluating participants' mood changes during the seminars.

Seminars Design

In the first seminar, the participants planned and built medieval castles. The main objective of the first seminar was to build a representative castle for the Czech king with the help of traditional project management methods, namely the waterfall approach. This task required constructing a simplified castle

model using office paper and tools like scissors, glue, wooden skewers, and crayons. We posed several functional and non-functional requirements for the castles. The participants worked in small project teams, which they had assembled earlier, as this seminar was the fourth one out of the total six seminars in the course. In the first part of the workshop, each team elected a project manager and presented a detailed project plan. The project plan included all tasks vital to completing the castle, including task breakdown and estimates. We allowed the participants to start building only after they had prepared a complete project plan for the castle. The project manager was accountable for following the project plan and measuring the time spent on each task. Planning the projects took approximately 15 minutes for an average team while building the castles spanned around 60 minutes. We allocated the remaining time in the workshop to present the finished castles to other teams and complete the questionnaires for our research.

In the second seminar, the participants constructed robots from LEGO components. The robots should have represented the "state of mind and heart" of the young generation. We instructed the participants to use a simplified version of the Scrum agile method to assemble the robots. We showed them a sample robot as inspiration for their work. The participants worked in the same small teams as in the previous practical seminar. Each of the second seminars took place exactly four weeks after the first one, being the last seminar the participants attended in the course. We have not specified detailed requirements to encourage creativity and innovation, as these feats are essential for agile development. In the first part of the workshop, each team appointed a Scrum master and a product owner. Then, they put together an initial product backlog with user stories that were eligible to build the robots. Due to limited seminar time, we used a simplified version of Scrum. Each sprint took 10 minutes as we merged all Scrum events into one short meeting between each sprint. This session included review, retrospectives, daily Scrum, and planning. The majority of teams managed to complete four sprints during the seminar. In contrast with the fixed project plan for building castles, the participants frequently added new user stories and updated existing stories in the product backlog. New user stories directly addressed the difficulties and creative ideas that emerged during the building. Similarly to the first seminar, the remaining time at the workshop was reserved to present the robots to the other colleagues, provide feedback, and provide questionnaires for our research.

Questionnaire Survey

We utilized online questionnaires to collect the answers. The questionnaire forms implement the Czech version of POMS by Stuchlíková et al. (2005). The forms contain 37 questions and adjectives about respondents' mood states in the Czech language. See the appendix for a complete list of questions. We prepared separate forms for both traditional and agile project management seminars and named them accordingly. Furthermore, we marked the questionnaires to be filled in before and after the management games as "variant A" and "variant B". Each questionnaire and its variant included

equal questions, as required by the POMS method. We arranged 8 individual seminars (two for each study group) and thus utilized a total of 16 forms as a combination of:

- 2 seminar types (traditional and agile),
- 4 study groups (study groups 1 to 4),
- 2 variants (variant A and variant B).

In addition to the questions about the participant's actual mood state, the participants filled in the university e-mail address. The university e-mail addresses served as a unique identifier for the respondents. No further information was collected, such as name, surname, age, or gender. We also published each questionnaire only for a limited time window that matched the related seminar and study group to prevent the "completing the wrong form" family of errors. We used the first author's original content management system (CMS) app and website to implement fully responsible and user-friendly online questionnaire forms. The content management app stored the collected data from the forms in an SQL database.

Data Processing

After conducting all seminars, we processed and analyzed the data collected. This process involved data export from the content management system, data transformation, and data review, as displayed in Figure 1. First, we exported all database tables that contained information about the questionnaires to a local database for further processing. The exported database tables include forms (form components with titles and text content), responses (questions with adjectives), and answers (respondents' answers to the questions).

Figure 1: Data processing and analysis (source: own)

We also removed irrelevant metadata from the tables, such as information about modules and components in the CMS, text contents, foreign keys to system tables, and logs. We preserved the metadata necessary for further data analysis, most importantly foreign keys and relations between tables for questionnaire forms, responses and answers, and form titles that include seminar information. Second, we transformed and encoded values for seminar types from the form titles (i.e., "agile seminar, even week, Tuesday, 15:45" → agile_project_management) and study groups (i.e., "agile seminar, even week, Tuesday, 15:45" → 3). We also transformed e-mail addresses to lowercase to prevent case mismatch errors. Finally, we substituted the respondents' e-mail addresses with anonymized hashes using the SHA-256 hashing function. The hashes serve as unique identifiers for the respondents and ensure the anonymity of respondents in output data and statistical analysis.

After the data export and transformations, we reviewed the data in the database for eligible respondents and possible errors. For our research, we required that the respondents fill in all four questionnaires in the seminars to compare their mood states during a particular seminar and between traditional and agile project management seminars. Therefore, we removed respondents with less than four filled-in questionnaires from the database, mostly due to absences from the practical seminars. We also deleted one respondent who answered all questions in all four forms with the same answers (invalid data). Finally, we exported two datasets in CSV format for further statistical analysis. The first dataset includes normalized records for form, responses, and answers, while the second dataset consists of records with aggregated answers. For data processing and analysis, we used SQL programming language.

Statistical Analysis

Based on the research questions, our experience from conducting the seminars with the participants, and previously analyzed data, we formulated seven hypotheses that presume improvement in participants' total mood state, vigor, and fatigue during the seminars:

- H1: the overall mood of participants has improved during practical traditional project management seminars.
- H2: the mood of the participants improved during practical agile project management seminars.
- H3: the overall mood of participants has improved in agile project management seminars.
- H4: the vigor of participants has increased during traditional project management seminars.
- H5: the vigor of participants has increased during agile project management seminars.
- H6: the fatigue of participants has decreased during traditional project management seminars.
- H7: Fatigue of participants has decreased during agile project management seminars.

Considering the factors, we focused on vigor and fatigue. Vigor is the only factor that indicates a positive mood. In our research, vigor represents participants' activity and energy before and after engaging in the management games and teamwork in the seminars. Fatigue is an important factor that reflects participants' stress and exhaustion before and after the seminars. In statistical analysis, we calculated partial factor scores for each record, then computed Total Mood Disturbance (TMD) from the factor scores and performed statistical tests for the hypotheses, as shown in Figure 2.
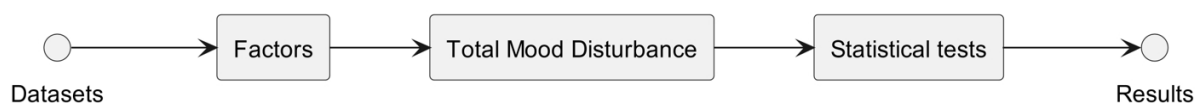

Figure 2: Statistical analysis (source: own)

For calculations, we utilized the scoring instructions for the Czech version of the POMS method, adding a constant of 100 to eliminate the possibility of a negative score for TMD. Consequently, we tested the formulated hypotheses using a two-sided Wilcoxon signed-rank test of difference for two paired data samples. The statistic for the test is the sum of the ranks of the differences above or below zero, whichever is smaller (Wilcoxon, 1945). We selected a non-parametric test because the data sample is relatively small and slightly skewed, so we cannot confirm the normality of the data using standard normality tests. For hypothesis testing, we set the level of significance to 0.05. We utilized Python programming language and the Jupyter ecosystem (pandas, NumPy, SciPy, and matplotlib libraries) for computing and statistical analysis.

RESULTS

We received 196 questionnaire forms from 49 eligible respondents in four study groups. The study groups included 15, 13, 10, and 11 respondents for study groups 1 to 4, respectively. The respondents filled in two questionnaire forms at the first seminar, which focused on a traditional project management serious game, and two questionnaire forms at the second seminar, which concentrated on an agile project management serious game. For each seminar, the respondents filled in the first questionnaire form (variant A) before starting the serious management game associated with the seminar and the second form

(variant B) after finishing the game and presenting the results to colleagues. First, we analyzed changes in Total Mood Disturbance (TMD) scores during the seminars and compared results between both seminar types. Second, we analyzed selected factor scores, namely vigor and fatigue.

Total Mood Improvement

Regarding hypotheses H1 and H2, we evaluated the total change in participants' mood during the seminars. We measured total mood change as a difference between TMD scores for questionnaires that respondents filled in before and after the same seminar (variants A and B). Lower TMD scores indicate a better mood state. Hence, the total mood improvement is represented by a decrease in the score. Table 1 presents descriptive statistics of the TMD scores obtained from the questionnaires. The table displays the sample size ($n = 49$) and mean values for both seminar types and questionnaire variants. The mean values for each variant A are higher than the mean values for the corresponding variant B. This difference in means applies to both traditional project management seminars (121.5 for variant A and 111.9 for variant B) and agile project management seminars (127.0 for variant A and 115.7 for variant B). The standard deviation is higher for the agile seminars (24.52 and 23.78 versus 19.12 and 20.33 for variant A and variant B, respectively). Minimum and maximum scores range from 76 to 196. The most extreme values are associated with variant B of the agile seminar questionnaire.

		n	Mean	Std. dev.	Min	Max
Traditional project management	Variant A	49	121.5	19.12	90	180
	Variant B	49	111.9	20.33	80	180
Agile project management	Variant A	49	127.0	24.52	85	184
	Variant B	49	115.7	23.78	76	196

Table 1: Descriptive Statistics for Total Mood Disturbance Scores (source: own calculation)

Based on the data, we tested the first two hypotheses to see whether the total mood of the participants improved significantly during the practical seminars. We tested hypothesis H1 regarding the traditional project management seminars and hypothesis H2 regarding the agile project management seminars. For both H1 and H2, we found statistically significant differences in the TMD scores between the beginning and end of the seminars, with p-values lower than 0.001 (see Table 2). Both p-values of < 0.001 are below the threshold of 0.05. Hence,

the results are consistent with our hypotheses that the total mood of participants has improved during the seminars. The results indicate that practical seminars and serious management games positively impact participants. Based on the outcomes for H1 and H2, we can answer the first research question: the total mood of the participants has improved during the traditional and agile project management seminars. Table 2 displays statistical details of the two-sided Wilcoxon tests for hypotheses H1 and H2, including the test statistics and p-values.

	Hypothesis	Test statistic	p-value
Traditional project management seminars	H1	242.0	< 0.001
Agile project management seminars	H2	274.5	< 0.001

Table 2: Statistical Test Results for Total Mood Improvement between Variants A and B (source: own calculation)

For hypothesis H3, we analyzed differences in total mood improvement between different study groups. We assessed differences in total mood improvement between traditional and agile project management seminars for each study group. Figure 3 presents a chart with TMD scores for individual traditional project management seminars, while Figure 4 presents

a comparable chart for individual agile project management seminars. Study groups are plotted on the horizontal axis in the charts, and TMD means are plotted on the vertical axis. The study groups are labeled as No. 1-4 in the charts. Both charts include TMD scores for both questionnaire variants and standard deviations, modeled as thin vertical lines.
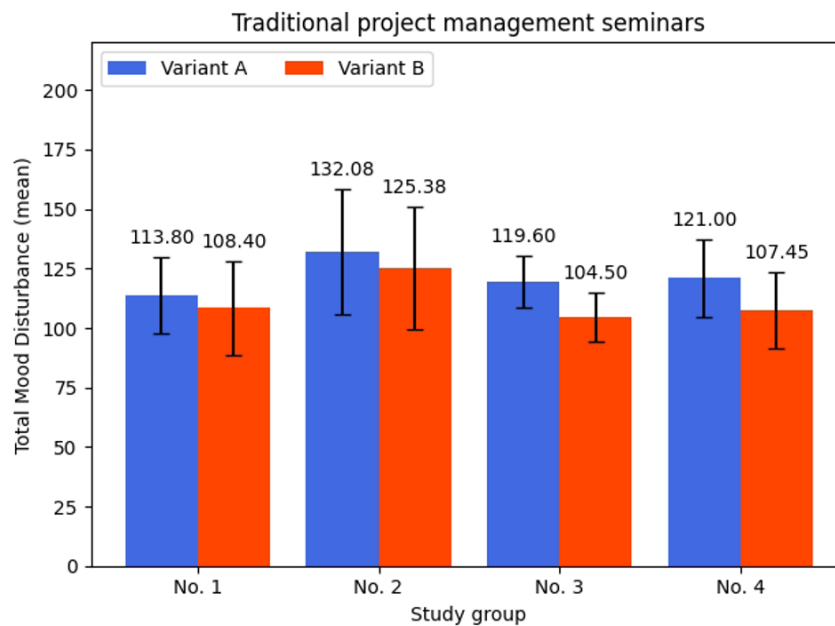
Figure 3: Total Mood Disturbance in Traditional Project Management Seminars (source: own calculation)
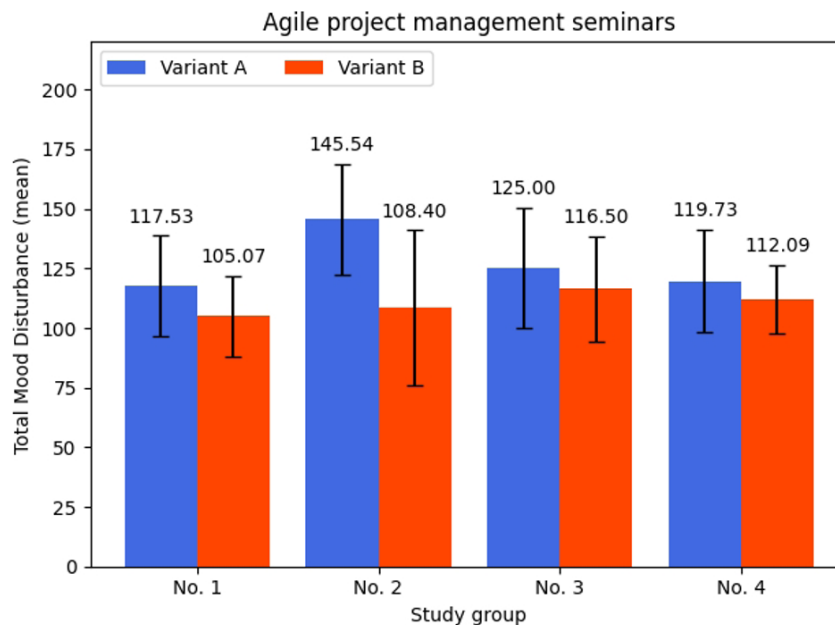

Figure 4: Total Mood Disturbance in Agile Project Management Seminars (source: own calculation)

The charts in Figures 3 and 4 show that the TMD scores have decreased for all participants in all four study groups and both seminar types. Hence, their total mood has improved, as a lower score reflects a more positive mood, and a decrease in the score indicates mood improvement. Table 3 summarizes all study groups and seminar types' total mood improvement ratios (in %).

	Study group 1	Study group 2	Study group 3	Study group 4
Traditional project management	4.98 %	5.34 %	14.45 %	12.61 %
Agile project management	11.87 %	34.26 %	7.30 %	6.81 %

Table 3: Total Mood Improvement per Seminar Type and Study Group (source: own calculation)

We tested hypothesis H3 to determine whether the total mood improvement differs between the traditional and agile project management seminar types. We calculated the total mood difference as the difference between the total mood improvement for agile and traditional seminars for each study group. We re-used the total mood differences we had computed for the previous statistical tests regarding hypotheses H1 and H2. We rejected hypothesis H3 based on the p-value of 0.883, which exceeds the threshold of 0.05 (see Table 4). The result indicates that the level of total mood improvement does not differ significantly between both seminar types. Therefore, we can answer the second research question: We do not

observe a significant difference between total mood change for traditional and agile project management seminars. Table 4 displays statistical details of the two-sided Wilcoxon test for hypothesis H3, including the test statistic and *p*-value.

	Hypothesis	Test statistic	*p*-value
Difference between seminar types	H3	597.0	0.883

Table 4: Statistical Test Results for Total Mood Difference Between both Seminar Types (source: own calculation)

Vigor and Fatigue

After investigating and testing total mood changes and improvement, we analyzed changes in vigor and fatigue scores. We tested two hypotheses related to vigor, H4 and H5, and two hypotheses related to fatigue, H6 and H7. First, we examined the aggregate factor scores for both seminar types. We have already calculated the individual factor scores necessary for calculating the TMD score and testing hypotheses H1, H2, and H3 (see Formula 1). Figure 5 displays a chart with factor scores before and after playing the serious management game at traditional project management seminars. In the chart, factors are plotted on the horizontal axis, and factor scores are plotted on the vertical axis. The factor scores are aggregated for all study groups.
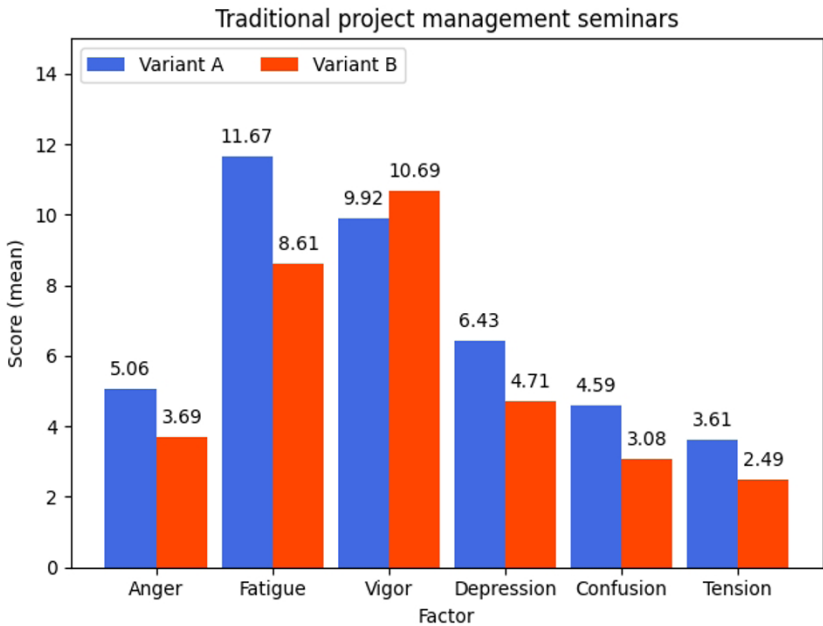

Figure 5: Factor Scores for Traditional Project Management Seminars (source: own calculation)

Figure 6 displays an equivalent chart for factor scores before and after playing the management game at agile project management seminars. Consistent with the previous chart, factors are plotted on the horizontal axis, factor scores are plotted on the vertical axis, and the factor scores are aggregated for all study groups. Both charts express similar general trends, as all factor scores improved after finishing the management games at the seminars.

As displayed in the charts in Figures 5 and 6, vigor scores have increased because vigor reflects a positive mood state. The remaining factor scores have decreased as the remaining factors indicate negative mood states. Although the charts show similar trends in the factor score improvements, the improvement ratios for vigor and confusion differ for both seminar types, as summarized in Table 5.

	Anger	Fatigue	Vigor	Depression	Confusion	Tension
Traditional project management	37.00 %	35.54 %	7.82 %	36.36 %	49.00 %	45.08 %
Agile project management	32.60 %	44.31 %	56.60 %	36.73 %	18.02 %	42.86 %

Table 5: Factor Improvement Ratios per Seminar Type (source: own calculation)

Regarding hypotheses H4 and H5, we analyzed the changes in participants' vigor scores, available from the questionnaire forms data. Similarly to the total mood changes, we calculated changes in vigor scores as the difference between the vigor scores from questionnaires that the respondents filled in before and after the same seminar (variants A and B). As previously mentioned, a higher vigor score indicates a better mood state of the participant. In Table 6, we display descriptive statistics for vigor scores. The table includes the sample size for each questionnaire ($n = 49$), means, standard deviation, and minimum and maximum values for both seminar types and questionnaire variants. The mean values are higher for variant
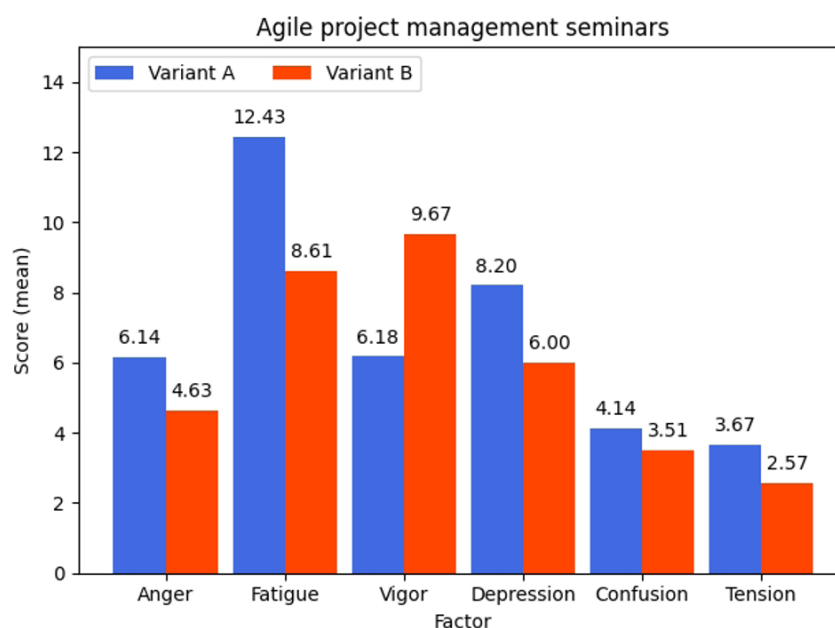
Figure 6: Factor Scores for Agile Project Management Seminars (source: own calculation)

B in both traditional project management seminars (10.69 versus 9.92 for variant A) and agile project management seminars (9.67 versus 7.61 for variant B). The higher mean values reflect the visual improvements that can be observed from the charts. The standard deviation values range from 4.15 to 4.89 for all combinations. Minimum and maximum vigor scores range from 0 to 24.

		n	Mean	Std. dev.	Min	Max
Traditional project management seminars	Variant A	49	9.92	4.77	0	24
	Variant B	49	10.69	4.89	2	24
Agile project management seminars	Variant A	49	7.61	4.15	0	16
	Variant B	49	9.67	4.79	0	24

Table 6: Descriptive Statistics for Vigor Scores (source: own calculation)

We tested the H4 and H5 hypotheses to verify if the vigor of the participants increased significantly after completing the serious management games, as the charts in Figures 5 and 6 suggest. We tested hypothesis H4 related to the traditional project management seminars and hypothesis H5 related to agile project management seminars. We rejected hypothesis H4 for traditional seminars based on the *p*-value of 0.602, which is greater than the threshold of 0.05. The result indicates that the vigor of the participants has not improved significantly during traditional project management seminars. Contrary to hypothesis H4, we cannot reject hypothesis H5, based on the *p*-value of 0.014 being lower than the threshold of 0.05. Table 7 displays statistical details about two-sided Wilcoxon tests for hypotheses H4 and H5, including the test statistics and p-values. These outcomes indicate that only the agile serious management game had a statistically significant positive impact on participants' vigor during the seminars, answering the third research question: There is a difference in vigor changes between traditional and agile project management seminars, as only agile project management seminars have a positive impact on the vigor of the participants.

	Hypothesis	Test statistic	*p*-value
Traditional project management seminars	H4	493.0	0.602
Agile project management seminars	H5	270.0	0.014

Table 7: Statistical Test Results for Vigor Improvement between Variants A and B (source: own calculation)

For hypotheses H6 and H7, we studied changes in participants' fatigue scores comparatively to the changes in vigor scores in the previous hypotheses. We calculated changes in fatigue scores as the difference between the fatigue scores from variants A and B. In contrast to the vigor score, a lower fatigue score signifies less mood disturbance and, thus, a better mood state of the participant. Table 8 presents descriptive statistics for fatigue scores. The table displays the sample size for each questionnaire ($n = 49$), means, and other statistical parameters for both seminar types and questionnaire variants. The mean values are lower for variant B, indicating that fatigue decreases for both traditional project management seminars (8.61 versus 11.67 for variant A) and agile project management seminars (8.61 versus 12.43 for variant A). Standard deviation values range from 5.57 to 6.64. Minimum and maximum vigor scores range from 0 to 24, like the minimum and maximum vigor values.

		n	Mean	Std. dev.	Min	Max
Traditional project management seminars	Variant A	49	11.67	5.57	1	24
	Variant B	49	8.61	6.64	0	24
Agile project management seminars	Variant A	49	12.43	6.31	0	24
	Variant B	49	8.61	6.11	0	24

Table 8: Descriptive Statistics for Fatigue Scores (source: own calculation)

We tested hypotheses H6 and H7 to determine whether the decrease in fatigue reductions advocated by the visuals in Figures 5 and 6 are statistically significant. We tested hypothesis H6 regarding traditional project management seminars and hypothesis H7 regarding agile project management seminars. For both hypotheses H6 and H7, we observed statistically significant differences based on p-values of < 0.001 that are lower than the threshold of 0.05. The results support our hypothesis that the seminars positively affect the participants' fatigue. For statistical details, including the test statistics and p-values, see Table 9.

	Hypothesis	Test statistic	*p*-value
Traditional project management seminars	H6	159.0	< 0.001
Agile project management seminars	H7	113.0	< 0.001

Table 9: Statistical Test Results for Fatigue Improvement between Variants A and B (source: own calculation)

The results indicate that participants' fatigue has decreased for both seminar types. Therefore, we can answer the last research question: Traditional and agile project serious management games have similar positive impacts on participants' fatigue.

DISCUSSION

In our research, we confirmed that the participants' total mood improved after finishing serious management games in both traditional and agile project management seminars. We observed no significant differences in Total Mood Disturbance improvement between both seminar types. Moreover, we learned that the participants' vigor improved only in the agile project management seminars, while fatigue decreased in both seminar types.

In a study by Paasivaara et al. (2014), the students learned basic Scrum concepts using a LEGO-based simulation game. The paper describes that the participants were generally satisfied with the game and learned much. Barcelos Bica and Gouvea da Silva (2020) conducted a similar management game that utilized LEGO blocks for building cities. The study concludes that students considered this activity very effective and practical for learning Scrum. Both studies utilized a comparable approach to our agile seminars, where the participants constructed robots from LEGO components. The outcomes of both referenced papers correspond to the improvement of participants' total mood and vigor in our agile seminars. Improved vigor signifies higher energy, activity, and satisfaction. Havazík and Pavlíčková (2020) mention that the Scrum-based agile game helped the majority of students understand the basic concepts of the agile approach. Considering the lack of significant difference in mood improvement between both seminar types, we can relate to the observations by Miller and Vaca Núnez (2022), who designed a management game to experience the differences between waterfall and agile approaches. The authors point out similar imbalances for both approaches at the start and during the games, including more planning, fewer decisions for the traditional approach, shorter start-up times, and more decisions later in the game.

The results of our research will be used to improve practical seminars and serious management games used in the seminars as an integral part of a project management course. We have confirmed that practical seminars with physical activities positively influence project management education, especially in developing soft skills and teamwork experience. Our results correspond to the previous research conducted by De Gloria et al. (2014) and Hellström et al. (2023), which found that serious management games have positive motivational outcomes and offer a convenient, practical experience. Engaging in management games lowers participants' mood disturbance and fatigue and increases their total mood and vigor. The positive impact of agile management games is higher, as supported by our findings and the above-mentioned authors.

From the point of view of Profile of Mood States, Berger, and Motl (2000) summarize that many studies associated with this method indicate positive relationships between physical exercise and mood changes. White et al. (2017) describe that practicing physical exercises is associated with improvement in mental health and mood, similar to our research outcomes. Research 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 is higher with verbal encouragement from the teacher.

Limitations

In the paper, we focused mainly on differences in total mood disturbance between the seminar types and during the seminars without a detailed analysis of the individual factors. Regarding the factors, we analyzed only vigor and fatigue as the most important factors from the perspective of project management and teamwork. We may examine the remaining factors and provide further details in the follow-up research. In addition, our research was limited by the size of the data samples. We have used different, not the same, management games and tasks for practical seminars that may have influenced the research to some extent. However, it is not feasible to use the identical management game for both seminars due to the differences between traditional and agile project management approaches. Each of the two project management approaches uses a different model for teamwork and involves different relations,

ERIES Journal
volume 18 issue 2

Electronic ISSN
1803-1617

Printed ISSN
2336-2375

87

interactions, and emotional states between the team members. We also connected our research to the existing management games that have been utilized in the last five years.

We organized our research as a pilot study, limited to four study group participants. We utilized a psychological method that required respondents to fill in a pair of questionnaires at each seminar, totaling four questionnaires per respondent. The agile (second) seminars were the last seminars in the project management course and took place slightly before the Christmas holidays. Thus, many respondents were absent from the seminars, reducing the number of eligible participants. Next year, we will address this limitation by changing the order of practical seminars on the course and extending the research and questionnaire survey to more study groups. Because of these improvements, we expect more respondents and a better return rate for the questionnaires.

CONCLUSIONS

We arranged two seminars for the project management undergraduate course participants, utilizing serious management games. The seminars and management games focused on practical traditional and agile project management experience. We utilized an online questionnaire survey based on the Czech version of the POMS method to collect quantitative data about participants' mood states. Following the data processing and statistical analysis, we answered four research questions related to the paper's main objective. We confirmed an improvement in total mood improvement, a decrease in fatigue for both seminar types, and an increase in

vigor for agile seminars of eligible participants who attended the seminars. Our results are consistent with the findings of contemporary authors in related research areas.

For further research, we may extend our work in three main directions. First, we will perform a more detailed analysis of the factors. In the follow-up research, we will analyze all six factors and their changes using the same data as in this paper, extending our findings about vigor and fatigue. We will also aim at the fine points and differences in individual factor scores between the study groups, not only between the seminar types. Second, we will repeat the practical seminars with questionnaire surveys for next year's run of the same undergraduate project management course. The new seminars will take place in November and December 2024. We will preserve the general concept of two practical seminars with serious management games that we have described in the paper. The requirements and conditions for the seminars will remain approximately the same to guarantee a sound comparison between the seminars of both years. We will slightly improve the seminars and adjust the management games according to the findings in this paper. We will extend the survey to additional study groups to secure a larger data sample if possible. Third, we propose implementing a comprehensive software solution to support our future research and help extend our method and research beyond project management courses into organizations and companies that utilize agile project management methods. The software solution should include a back office for managing questionnaires and study groups and simplify data gathering.

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LIST OF PROFILE OF MOOD STATES ADJECTIVES (QUESTIONS)

Czech adjectives are not always direct 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 10: List of Adjectives in the Czech Version of Profile of Mood States Questionnaire (source: Stuchlíková et al., 2005)