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Tables, graphs and illustrations should be drawn using a suitable drawing package. Colour may be used. Place all diagrams and tables where you wish them to appear in the paper. Ensure your diagrams fit within the margins and are resizable without distortion.

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Following Editorial recommendation, papers are submitted to a double-blind peer review process before publication. Commentary by reviewers will be summarized and sent by email to authors, who can choose to revise their papers in line with these remarks. Re-submitted papers should be accompanied by the description of the changes and other responses to reviewers' comments (see above), so that the desk-editor can easily see where changes have been made.

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We are delighted to share with our readers the results of the annual evaluation of the ERIES Journal in the Scimago Journal & Country Rank. In the 2025 edition, the ERIES Journal was ranked again in Q3 in the Education category, with an SJR of 0.356, representing an annual growth of 47.7% compared to the previous edition. In addition, the ERIES Journal recorded +67.5% citation growth, 1.967 citations per document (+44.6% compared to 2023), and the share of uncited documents to cited documents decreased by 36.9%. As a result, the journal was evaluated as the best journal in the education category in the Czech Republic. Finally, the journal was also ranked in the Q2 within the Education & Educational Research category in the Emerging Sources Citation Index (ESCI). This positive result is a commitment for us to keep the established editorial policy to deliver published content of the highest quality.

In this second issue of 2025 (Vol. 18, No. 2), we are delighted to present six articles from different regions around the world: Croatia, the Czech Republic, Indonesia, and the Phillippines. The published articles examine a wide range of educational and psychological dynamics within learning and teaching environments. Central themes include teachers' instructional beliefs and leadership approaches, students' emotional and cognitive development, and the intersection between academic workload and mental health.

In the first article, " Countryside Secondary School Science Teachers' Teaching Beliefs, Scientific Epistemological Beliefs, and Approaches to Teaching", Reymund Derilo examined the teaching beliefs of secondary school teachers. The author employed a convergent parallel mixed-methods design, consisting of a semistructured interview with 54 secondary school science teachers, followed by a descriptive-correlational design to investigate the relationship between their scientific epistemological beliefs and pedagogical approaches. The analysis discovered that most teachers prioritize creating a student-involved classroom environment, typically teacher-initiated learning, rather than allowing student-led initiatives. They generally view themselves as facilitators of learning, base their teaching decisions on the curriculum, and believe that students demonstrate understanding by reiterating what has been taught.

In the second article, "Mood States as a Key Factor in Assessing Student Learning in Project Management Teaching", Josef Kunhart and Jan Bartoška investigated whether the serious management games provide the expected learning experience consistent with current practical project management practice in organizations that use the Scrum method for managing projects. The authors employed the Profile of Mood States psychological method to assess the total mood changes of 49 students enrolled in the Planning and Project Management undergraduate course. The research found that students' total mood and fatigue have improved significantly during practical seminars, confirming that serious management games have a positive effect on student learning and experience. The authors also observed no significant difference in total mood improvement between traditional and agile seminars.

In the third article, " Students' Attitudes toward the Annual Instrumental Exam in Croatian Elementary Music Schools", Jasna Šulentić Begić, Amir Begić, and Ivana Sabolek analyzed complex patterns of performance anxiety in music school students during annual exams, focusing on how gender, age, instrument type, and family musical tradition interact. The study was conducted on a sample of 143 third- to sixth-grade students of public elementary music schools in Croatia, applying a 14-item Likert-scale questionnaire. Results show high levels of pre-exam stress, especially among girls and piano students. In contrast, younger students reported more positive emotions before the exam, and older students were calmer afterward. The findings highlight the need for pedagogical measures to mitigate exam-related stress, including enhanced psychological preparation for students, adjustments to the evaluation system, and supplementary teacher training to address students' emotional needs.

In the fourth article, "Exploring How Change Leadership Influences Instructional Leadership Effects on School Culture and Teachers' Teaching Performance in Pesantren Education Settings in Indonesia: a Moderated-Mediation Analysis", Desi Eri Kusumaningrum, Imam Gunawan, Raden Bambang Sumarsono and Retnani Latifah investigated the moderated mediation model of how change leadership impacts instructional leadership effects on school culture and teachers' teaching performance. The authors surveyed 459 junior high school teachers from 39 pesantren in Indonesia, and the collected data were then examined with factor analysis and Hayes' bootstrapping technique. The results of the analysis indicate that the principal's instructional leadership has both direct and indirect effects on teachers' teaching performance through the school culture. In this case, when the professional relation-

ship between teachers and their principals is characterized by higher change leadership, the indirect effect of the principal's instructional leadership on teachers' teaching performance, mediated through school culture, is greater.

In the fifth article, "Too Much of Everything Is Bad: the Case of Czech University Students' Work--Study Balance During the Covid-19 Pandemic", Michaela Prokes and Jan Klusacek focused on students' dilemma how to combine the demands of their studies and the necessity to work. The objective of the analysis was to explore the relationship between workload, study, and depressive symptoms. The authors used linear multiple regression and analyzed a repeated cross-sectional sample of 8,584 Czech university students at two time points (2020 and 2021) during the pandemic outbreak. The analysis demonstrates that employment benefits students' mental health, but students who worked extra hours had more depressive symptoms than those who worked part-time or full-time. In addition, an increasing study load had a negative effect on students in the form of increased depressive symptoms.

In the sixth article, "The Role of Academic Resilience, Self-Regulation, and Perceptions of Chemistry Students in Academic Achievement: a Structural Equation Modelling (SEM) Approach", Desfi Annisa, Hari Sutrisno, and Endang Widjajanti assessed how high school academic resilience, self-regulation, and students' perceptions affect their academic achievement in chemistry classes. The analyzed sample included 791 high school students from 14 schools in Pekanbaru and its surrounding areas in Indonesia. The linear relationship model between academic resilience, self-regulation, student perceptions, and achievement in chemistry was examined using the Structural Equation Modelling (SEM) method. The results indicate that chemical achievement correlates negatively with academic resilience, significantly positively with self-regulation, and negatively and insignificantly with student perception. The authors recommend that teachers should focus more on the qualities of their students and incorporate learning activities to improve student's learning outcomes.

We would like to thank all authors who have submitted their articles to the ERIES Journal and extend special thanks to all reviewers for their tireless efforts in revising the articles. We hope all our readers will find this second issue of the year interesting. You can follow the latest updates related to the ERIES Journal on its LinkedIn page, where we post information about the most cited articles, related upcoming events, and calls for special issues.

Sincerely

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CONTENT

DO TEACHERS' BELIEFS TURN TO PRACTICE? COUNTRYSIDE SECONDARY SCHOOL SCIENCE TEACHERS' TEACHING BELIEFS, SCIENTIFIC EPISTEMOLOGICAL BELIEFS, AND APPROACHES TO TEACHING

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ABSTRACT

This study employed a convergent parallel mixed-method design to examine the teaching beliefs of secondary school teachers and determine the relationship between their scientific epistemological beliefs and pedagogical approaches. Semi-structured interviews were utilized to explore teachers' teaching beliefs, while quantitative analysis involved a descriptive-correlational approach, employing two adapted questionnaires: Scientific Epistemological Belief Questionnaire (SEBQ) and Approaches to Teaching (ATI). Analysis of interview responses reveals that most teachers prioritize creating a student-involved classroom environment, typically teacher-initiated learning, rather than allowing student-led initiatives. They generally view themselves as facilitators of learning, base their teaching decisions on the curriculum, and believe that students demonstrate understanding by reiterating what has been taught. Quantitative analysis indicated that science teachers in the province largely demonstrate traditional beliefs regarding the origins and characteristics of scientific knowledge while predominantly employing transitional teaching approaches in their practice. Furthermore, the study found a correlation between teachers' SEBs and adopting learner-focused teaching approaches. Integration and meta inference of qualitative and quantitative findings bear significant implications for science education, suggesting avenues for enhancing, restructuring, and reforming teachers' teaching and epistemological beliefs. Hence, efforts should focus on fostering teachers' deeper understanding of the nature of science.

KEYWORDS

Approaches to teaching, nature of science, teaching beliefs, scientific epistemological beliefs

HOW TO CITE

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Highlights

- *Teachers' interview responses reveal diverse instructional beliefs, characterized by a notable prevalence of instructive and transitional belief orientations.*
- *The majority of the science teachers exhibit fairly traditional scientific epistemological beliefs.*
- *Significant and moderate correlations exist between teachers' approaches to teaching and their scientific epistemological beliefs.*
- *Integration and metainference of qualitative and quantitative findings revealed areas of convergence and divergence, offering significant implications for science education and basic education policy reviews.*

INTRODUCTION

The prime objective of teaching at any education level is to bring about a significant and fundamental transformation in the learner (Tebabal and Kahssay, 2011). To enhance knowledge transfer, teachers should use suitable teaching approaches, methods, and strategies that align with specific goals and desired outcomes. Educational researchers have long been intrigued by questions regarding how teachers select

their teaching methods and strategies. Additionally, unresolved aspects include the factors influencing these choices and decisions and why some teachers favor teacher-focused rather than student-focused approaches.

Beliefs are critical when understanding a teacher's practice (Luft and Roehrig, 2007). What a teacher does in the classroom is representative of his beliefs (Wallace and Kang, 2004). Teachers' action-oriented approach to science learning is needed; this requires recognizing that students can and should be encouraged to learn science in their everyday lives as there are numerous contexts outside the classroom wherein students can learn about science (Bencze et al., 2009). Learning would take place with the appropriate teachers' attitudes, emotions, and views of the nature of science, coupled with effective pedagogical content knowledge (Van Driel et al., 2007).

Teachers' beliefs have been found to have a positive correlation with practice. There is a positive correlation between teachers' beliefs and teachers' instruction and learning of science, what is introduced to as "nested" epistemological views (Tsai, 2002). While there is instability about where these beliefs stem from, Tsai's finding gives an essential example of how epistemological views about teaching and learning can and do influence classroom practice. Several research findings likewise give data about how empirical science perspectives rise above societies and may be identified with teachers' classroom experience (Donnelly, 1999; Gustafson and Rowell, 1995; Koballa et al., 1990; Tsai, 2002). If these perspectives on teaching and learning play a significant role in shaping practices, they should grab the attention of the science education community. How teachers' views and beliefs translate into action becomes extremely crucial, especially when considering how learners develop their belief systems through instruction. Teachers who align with a more constructivist perspective on learning are likely to consider how learners understand concepts (Hashweh, 1996).

Teachers' choice of teaching methods and strategies is influenced by various factors, with a significant impact on their epistemic beliefs (EBs) (Keys and Bryan, 2001). Scientific epistemological beliefs (SEBs) specifically pertain to beliefs about the source and nature of scientific knowledge (Hofer and Pintrich, 1997). SEBs can be classified as traditional or contemporary, reflecting views on the exactness and changeability of scientific knowledge (Bråten and Strømsø, 2005). SEBs shape each element of the teaching process and guide teachers in their decisions and choices (Putnam and Borko, 1997). Studying teachers' epistemological beliefs is crucial for understanding their conceptualization of work, teaching practices, and decisions in the classroom (Olafson and Shraw, 2010). Mansour (2009) emphasizes the powerful influence of teachers' beliefs over their insight in shaping how they deliver knowledge. When teachers hold static or dynamic conceptions of science, their objectives align with either performance or mastery goals (Chen and Pajares, 2010). Individual conceptions about knowledge and how individuals come to understand concepts are crucial elements in providing valuable insights into the mental processes of each individual (Hidayatullah and Csíkos, 2023).

As we navigate through the changing landscapes of educational philosophies such as constructivism and post-positivism, it becomes crucial to reassess the importance of SEBs in science education (Chen et al., 2014; Guilfoyle et al., 2020; Guo et al., 2022; Vieira et al., 2017; Yucel, 2018). Constructivism, emphasizing active student participation and knowledge construction, aligns with the study's exploration of how teachers' epistemological beliefs (SEBs) influence their instructional strategies. This philosophy posits that learners build upon their prior knowledge, and similarly, teachers' beliefs about science and its teaching evolve through experience. In contrast, post-positivism offers a more nuanced perspective on knowledge as tentative and subject to change, which mirrors the present study's examination of how teachers' beliefs about the nature of scientific knowledge influence their teaching approaches. These philosophical perspectives directly inform the research questions and methodology, guiding the investigation of the relationship between teachers' SEBs and their instructional choices and how these beliefs shape educational practices in science classrooms. Delving into teachers' teaching beliefs and epistemic beliefs offers valuable insights into how they shape their teaching approaches and strategies in the science classroom. Luft and Roehrig (2007) noted that making these beliefs "visible" is key to understanding and eliciting teachers' perspectives.

A review of existing literature on SEBs and teaching approaches reveals several notable research gaps. This study aims to address these gaps, particularly in understanding how educational policies, especially in rural Philippine contexts, influence the implementation of reform-based teaching practices despite teachers' positive beliefs about such methods. While the connection between teachers' epistemological beliefs (EBs) and teaching practices is well-established, there is limited exploration of how local policies, resources, and contextual factors shape these beliefs. Additionally, the study examines the barriers preventing teachers from aligning their beliefs with classroom practices, particularly in environments constrained by policy. Furthermore, the research highlights the lack of studies on how teachers' beliefs about the nature of science (NOS) influence their teaching approaches. Moreover, the scarcity of mixed-methods research designs to explore these complex issues represents a significant gap, as such approaches offer a more holistic understanding of the relationships between beliefs, teaching strategies, and educational outcomes in rural settings.

This study aims to uncover the beliefs of secondary school teachers in rural areas regarding their scientific epistemological development. By analyzing teachers' interview and survey responses, the study seeks to enhance understanding of the current challenges in basic science education within the locality. Specifically, the study intends to (1) explore the nature and development of teachers' teaching beliefs and scientific epistemological beliefs (SEBs) and examine how these beliefs influence their teaching practices; (2) assess the relationship between teachers' beliefs about the nature of science (NOS) and their teaching approaches; and (3) integrate qualitative and quantitative findings to provide a more comprehensive understanding of the interplay between teachers' beliefs, teaching strategies, and educational outcomes in rural science education. Through these objectives, the study

aims to contribute to the ongoing dialogue on improving science education in rural areas, focusing on the role of teachers' epistemological beliefs and teaching approaches.

METHODS

Design and Sample

In this research, a convergent parallel mixed-method design was employed. For the qualitative part of the study, a semi-structured interview was employed to determine the teachers' teaching beliefs using the interview guide developed by Luft and Roehrig (2007). This guide included 7 questions designed to elicit the teaching beliefs of each teacher, analyze their thoughts, and understand their beliefs. Once the responses were collected, they were inductively analyzed through the Content Analysis method (CA) to comprehend how certain perspectives were manifested within each teacher. Patton (1990) refers to this as an orientational methodology. For the quantitative aspect of the study, a descriptive-correlational design was used to determine secondary school science teachers' scientific epistemological beliefs and teaching approaches, as well as the possible association between these variables. The teachers were asked to complete two survey questionnaires: the Scientific Epistemological Belief Questionnaire (SEBQ) and Approaches to Teaching (ATI).

A letter to the Schools Division Superintendent (SDS) of the Department of Education - Nueva Vizcaya was sent for approval to conduct this study. Thereafter, an endorsement letter was provided and forwarded to the administrators of the secondary schools in the province. The sample of 54 secondary school science teachers who participated in the study was drawn from a diverse set of schools within the province, which provides a representative cross-section of the broader population of science educators. The selection process began with the endorsement of school administrators, who introduced the researcher to the science teachers within their institutions. All 54 teachers voluntarily agreed to participate, completing the survey questionnaires, and 18 also took part in brief interviews once data saturation was reached. This step ensures a balance of both quantitative and qualitative data. The sample offers insights into the perspectives and practices of science teachers in the province, including various educational backgrounds, specializations, and levels and years of experience. The specific focus on these teachers reflects the broader trends within secondary school science education, particularly in rural and provincial settings. By studying this sample, which mirrors larger schools in the region, the research can draw conclusions about the dynamics of science teaching in similar rural and underserved areas. This approach not only provides a micro-perspective on science education but also offers implications for educational policies and practices on a more macro level, enhancing the relevance and generalizability of the findings to other schools in similar contexts.

Instruments

Teachers Belief Interview (TBI). Luft's and Roehrig's (2007) TBI was used to document teachers' teaching beliefs. The tool consists of seven questions depicting epistemological beliefs in teaching and learning development. There are five belief categories: traditional, instructive, transitional, responsive, and reform-based. The tool has a Cronbach alpha coefficient for the internal consistency of 0.70. Teachers' beliefs were categorized into five, namely, traditional, instructive, transitional, responsive, and reform-based. Traditional beliefs focus on the transmission of information or reliance on established sources. Teachers adhering to these beliefs see their role as delivering information to students. On the other hand, instructive beliefs center around creating experiences that are teacher-focused or decided by the teacher. Teachers with instructive beliefs aim to provide students with hands-on experiences in laboratory science, which emphasizes a student-focused approach to minimize disruptions. On the contrary, Transitional beliefs occupy the middle ground between traditional and contemporary beliefs in teaching and learning science. These beliefs emphasize teacher-student relationships, subjective decisions, and emotional responses. Teachers with transitional beliefs feel responsible for guiding students in developing understanding and process skills, modifying their teaching to align with students' preferences to build rapport. In contrast, responsive beliefs revolve around collaboration, feedback, and knowledge development, with teachers setting up classrooms for students to take charge of their learning. Lastly, reform-based beliefs, the most modern among contemporary teaching beliefs, focus on mediating student knowledge and fostering interaction. In this approach, teachers provide experiences that help students comprehend their knowledge and make sense of science.

Scientific Epistemological Belief Questionnaire (SEBQ). The SEBQ used in this study was adapted from Baliton's (2005) master's thesis at the University of the Philippines – Diliman, with permission obtained via email from the original author. This survey instrument evaluates teachers' beliefs about various aspects of scientific knowledge, including scientific theory, the scientific method, scientific law, and the role and image of scientists. It employs a 4-1 Likert scale, allowing participants to express their level of agreement with statements about the nature of science. Notably, Baliton had previously applied the SEBQ to a sample similar to the target population of this study, further validating its relevance and applicability. Additionally, the instrument underwent pilot testing with a sample similar to the study's target group, though distinct from the final sample, to ensure its suitability and reliability. The SEBQ demonstrated strong reliability, with a Cronbach's Alpha value of 0.8583, which indicates excellent internal consistency. For analysis, the instrument classifies beliefs into four categories: traditional (M = 1.00–1.74), fairly traditional (M = 1.75–2.49), fairly contemporary (M = 2.50–3.24), and contemporary (M = 3.25–4.00). By adapting and validating the SEBQ for this study, its relevance and suitability for investigating science teachers' epistemological beliefs in rural Philippine schools are firmly established.

Approaches to Teaching (ATI). The tool was adapted from Trigwell and Prosser (2004). The ATI was intended to measure a teacher's approach to teaching about another construct, such as student learning outcomes, enthusiasm, or organization. There are two 11-item subscales within the ATI. The first is the information transfer/teacher-focused scale (ITTF), and

the second subscale is the conceptual change/student-focused scale (CCSF). There are no established normal values for the inventory as it is intended to be used in a relational way and may depend on context. Classification of teachers' approaches to teaching was determined based on their score range on the ATI. However, as a scoring guide, the following was used: for CCSF items, scoring was as follows: always true = 5; sometimes true = 4; true half the time = 3; frequently true = 2; and never true = 1. On the other hand, items representing ITTF approaches were scored in reverse. Cronbach's alpha values were 0.75 (CCSF approach) and 0.73 (ITTF approach). Scores were interpreted as follows: 22.0–39.6: knowledge transmission; 39.7–57.2: knowledge acquisition; 57.3–74.8: transitional stage; 74.9–92.4: conceptual development; and 92.5–110.0: conceptual change.

Analysis and Integration of Qualitative and Quantitative Results

This study followed the integration process through data transformation outlined by Fetters et al. (2013). The approach involves two main steps. First, qualitative data were converted into quantitative data through content analysis (Table 1), enabling the identification of teachers' beliefs in numerical form. Second, the transformed data were integrated and analyzed alongside the original, non-transformed data (discussion section). This integration facilitated a comprehensive discussion, combining insights from both qualitative and quantitative perspectives to provide a more robust understanding of the research findings. Moreover, integration by narrative was employed in analyzing teachers' teaching beliefs, approaches, and epistemological beliefs. Specifically, a weaving approach was used, where qualitative and quantitative findings were presented together on a concept-by-concept basis. This method allowed for a cohesive and interconnected discussion of the findings, highlighting the interplay between qualitative insights and quantitative evidence within each thematic framework.

RESULTS

Capturing Teachers' Teaching Beliefs

The TBI is intended to determine teachers' beliefs about the teaching and learning process inside a science classroom. To ensure the integrity of the collected data, teachers' responses were carefully categorized using the categorization guide by Luft and Roehrig (2007).

TBI Questions	Teachers' Classification (%)				
	Traditional	Instructive	Transitional	Responsive	Reform based
Q1. How do you maximize student learning in your classroom?	27.8	5.6	38.9	11.1	16.7
Q2. How do you describe your role as a teacher?	5.6	5.6	16.7	0	72.2
Q3. How do you know when your students understand?	0	61.1	22.2	11.1	5.6
Q4. How do you decide what to teach and what not to teach in the school setting?	66.7	16.7	16.7	0	0
Q5. How do you decide when to move on to the next topic in your class?	0	83.3	11.1	5.6	0
Q6. How do your students learn science best?	0	0	50.0	44.4	5.6
Q7. How do you know when learning is occurring in your classroom?	0	16.7	27.8	44.4	11.1

Table 1: Teachers' Beliefs Categorization Based on Their Responses to the Interview

Table 1 presents a classification of teachers' responses to the seven Teaching Beliefs Interview (TBI) questions. Regarding maximizing student learning (Q1), the data show that most teachers' beliefs are categorized under the transitional belief (38.9%). This means that most teachers focus on creating a classroom environment that involves the students but whose initiative starts with the teacher and not with the students themselves. Regarding the teacher's role description (Q2), 72.2% believe they are facilitators of learning and mediators of students' prior and pre-existing knowledge. On the other hand, the majority (61.1%) of the teachers have instructive beliefs about when a student has gained comprehension (Q3), which suggests that the majority believe in the notion that students have understood the lesson if they can already reiterate or demonstrate what has been presented in class. When deciding what to teach (Q4), most teachers (66.7%) possess teacher-focused, traditional beliefs, which suggests that the adopted curriculum guides most teachers in deciding what to teach and what not to teach.

Deciding when to move on to the next topic (Q5), most teachers predominantly fall into the instructive category (83.3%). This suggests that their decision when to move on to the next topic is teacher-directed and is based on a basic understanding of facts and concepts. Regarding how students learn science best (Q6), more than half of the respondents (50.0%) possess transitional beliefs, suggesting that most teachers believe that students learn science concepts best by doing or by involving the learners in various hands-on activities. Similarly, many of the respondents (44.4%) believe in a more contemporary belief displaying responsive beliefs on how a student best learns science concepts, implying that many teachers also believe that students learn science best by encouraging and challenging them to create their own understanding based on their observations.

Finally, in assessing when learning is occurring (Q7), most teachers (44.4%) hold contemporary, responsive beliefs, believing that it is when students start interacting with their peers or their teacher or when the students start defending their own ideas through evidence and examples that learning has already taken place in the classroom.

The following sections comprehensively present the results of the analysis from teachers' responses to the 7 questions. Sample responses were presented as examples.

How do you maximize student learning in your science classroom?

Some teachers who demonstrate traditional beliefs focus on structured environments where teachers manage time to enhance student learning. Teacher E stated, "*To maximize student learning in the classroom, time management is needed.*" On the other hand, teachers with instructive beliefs involve closely monitoring students' behaviors and engagement, with teachers like Teacher R emphasizing discipline, saying, "*I will not ignore misconduct in the class that will disturb other students. I believe that learning takes place in a disciplined class.*" These beliefs guide teachers in maintaining order to foster effective learning.

Most of the teachers interviewed demonstrate transitional beliefs. These beliefs revolve around shaping a classroom atmosphere that actively engages students. These are further subdivided into two categories: cognitive and affective. Cognitive beliefs may seem aligned with contemporary views; however, they are classified as transitional because the initiative originates from the teacher rather than the students. This distinction is evident in the perspectives of Teachers H and U, who advocate for providing hands-on activities and diverse experiences to guide students in constructing their ideas. Teacher H said, "*To maximize student learning in my classroom, I must provide various hands-on activities and first-hand experiences that will teach the students to construct their ideas.*" Teacher U emphasizes the importance of offering varied activities and strategies to address the diverse learning needs and challenges of students: "*I believe that by giving different sets of activities and strategies to cater to most of the learners' learning (needs and difficulties), I can maximize learning (in my classroom).*" On the other hand, affective beliefs center on teachers' emotional dispositions in expressing feelings accompanying ideas and actions. Teacher J held such beliefs when she said, "*I think I can maximize learning by fostering strong relationships with my students, both inside and outside the classroom*."

Some teachers' responses also reflect responsive beliefs. These beliefs are student-centered, focusing on creating classroom environments that encourage interaction and collaboration. Teacher D, for example, believes that "*group work discussions, brainstorming, Socratic method of teaching, silent reading, and analysis of extra reading materials*" enhance learning. At the same time, Teacher P emphasizes that "*interactions in all classroom activities promote better learning*." Some teachers, however, have shown reform-based beliefs that emphasize individualized learning, allowing students to choose their learning methods. Teacher N reflects this by stating, "*by giving differentiated instructions*," believing that students learn best when their interests and strengths are considered. This approach aligns with differentiated instruction, recognizing students' diverse learning styles.

How do you describe your role as a science teacher?

Some teachers demonstrate traditional beliefs, prioritizing structure and information in the classroom and viewing their role as knowledge providers. Teacher C, for example, describes teaching as a "*very tedious task, such as managing the class*," but adds, "*I find it enjoyable*," reflecting this approach's labor-intensive yet fulfilling nature. Other teachers exhibit instructive beliefs, focusing on providing experiences and managing classroom behavior. Teacher N, for instance, believes teachers should extend their roles beyond just education, stating that they must also act as mentors, disciplinarians, and even spiritual guides. Some teachers display transitional beliefs, emphasizing the importance of building strong connections with students and fostering a deep understanding of the subject. Teachers like D and O view their role as multifaceted, with Teacher D saying, "*Being a teacher means opening young minds to the wonders and realities of the world*," and Teacher O considering teaching a role of "*model, challenger, leader, counselor, mother, sister, and friend.*"

However, none of the teachers in this study demonstrated responsive beliefs that focus on collaboration between teachers and students and empowering students to take control of their learning. This suggests a gap in fostering collaborative, student-led learning environments.

It was found that most of the teachers demonstrate reform-based beliefs about their roles as science teachers. With this belief, the teacher's role primarily mediates between students' existing knowledge and the subject matter. Teachers view themselves as guides, assisting students in making sense of their surroundings in alignment with established knowledge. Two illustrative responses come from Teachers G and H. Teacher G said, "*My role is to facilitate learning and inspire students to make them enjoy the learning process, to discover new things through science.*" Likewise, Teacher H emphasizes "*the teacher's role as a facilitator of learning, to guide students to construct their understanding while correcting any misconceptions they may have.*"

How do you know when your students understand?

Traditional beliefs are embodied by teachers who believe that students have grasped a lesson when they can repeat information communicated by the teacher. According to these teachers, hearing this information from the students at least three times is crucial for confirmation. Notably, none of this study's respondents demonstrated such traditional beliefs. This absence of alignment with the mentioned beliefs among the interviewed teachers suggests a divergence from the notion that repetition and varied presentation formats are key indicators of lesson comprehension.

Most of the teachers, however, have demonstrated instructive beliefs. These are evident among teachers who gauge students' understanding based on their ability to articulate or demonstrate the content presented in class. These educators posit that true comprehension is demonstrated when students perform well on practical examinations, accurately reproduce answers on written tests, and articulate concepts using their own words. Teacher F's response clearly illustrates instructive beliefs: "*I know my students learn when they get high scores*

and can answer questions even if you paraphrase." Notably, Teacher F places significant emphasis on assessments, utilizing both formative and summative evaluations as key indicators of students' comprehensive understanding. This trend is similarly observed in Teacher I's response, where, in addition to assessments, he said, "*They learn when they have the ability to answer questions, even when rephrased, and it is considered a sign of students having fully grasped the lesson.*"

Some teachers demonstrate transitional beliefs, assessing understanding through students' ability to explain or respond in ways that connect with the lesson. This can be cognitive, like Teacher D using quizzes and oral reviews, or affective, based on students' facial expressions. Teacher D says, "*I just know*" when students understand. Teachers Q and R also emphasize cognitive and affective indicators, noting positive behavior and relevant questions as signs of comprehension.

Responsive beliefs are reflected in teachers who value students' ability to apply knowledge in discussions or real-life situations. Teacher H believes understanding is shown when students can "*apply or integrate or relate topics with other lessons*," while Teacher N values when students "*ask situations related to the topic.*"

Reform-based beliefs focus on applying knowledge in new contexts. Teacher G exemplifies this by stating, "*It is when they know to apply the theories learned through practical situations in life.*"

How do you decide what to teach and what not to teach in the school setting?

About one-third of the teachers interviewed demonstrate traditional beliefs shaped by strict adherence to the prescribed curriculum and external factors such as time constraints. These teachers prioritize covering all topics outlined in the curriculum. For instance, Teacher B states, "*I follow the CG (curriculum guide), TG (teacher's guide), and LM (learners' manual)… all the topics should be discussed.*" Teacher C adds, "*Competencies are non-negotiable; it should be taught*," while Teacher N emphasizes, "*The Department of Education already prepared curriculum guides, and I am teaching based on the competencies specified in the curriculum.*"

Other teachers exhibit instructive beliefs, where personal preferences, the relevance of content, and the availability of materials influence their teaching choices. Teacher K explains, "*When materials needed are not available locally and when the topic duplicates what has been taught in the previous grade*," indicating that the availability of resources and prior coverage guide her decisions. Teacher Q shares a similar view: "*Teaching should be based on what the students need and what is applicable in their community.*"

Transitional beliefs are evident in teachers who adjust their teaching based on student feedback and abilities. Teacher G states, "*Through initial assessment of students' knowledge about the topic, the resources provided by the school are used,*" indicating that students' understanding shapes instructional decisions. Teacher O ensures that "*at least 75% of the students have understood the lesson before proceeding to the next lesson,*" focusing on student comprehension before moving on.

Responsive beliefs are held by teachers who base their decisions on student feedback, interests, and misconceptions, believing that active engagement enhances learning. On the other hand, reform-based beliefs focus on a student-centered approach guided by research and educational standards to ensure content is appropriate and aligns with specified standards. Unfortunately, these beliefs were not reflected in the teachers' responses.

How do you decide when to move on to the next topic in your class?

Instructive beliefs, where teachers base decisions on students' grasp of concepts, are common among 83% of the respondents. Teachers like Teacher I, who move on when "*students could pass the summative test and could greatly tell what they have understood,*" reflect this belief. Similarly, Teacher V decides to proceed when "*students have already understood the topic*" and can demonstrate their knowledge through assessments. These teacher-directed decisions emphasize assessing student understanding before advancing.

In contrast, the responses did not reflect traditional beliefs, where decisions are driven by curriculum and time constraints. Transitional beliefs, seen in teachers like Teacher N, who waits for students to "*explain the topics through class recitation*," show reliance on student feedback. Responsive beliefs, exemplified by Teacher D, involve adjusting the pace based on student progress. At the same time, no teachers in the study demonstrated reform-based beliefs, which would involve ongoing evaluations to gauge readiness for new topics.

How do your students learn science best?

Half of the teachers interviewed in this study exhibited transitional beliefs, where teachers emphasized hands-on activities for effective learning. For instance, Teacher L believes students learn best "*when they perform laboratory experiments, demonstrations, and simulations*." Similarly, Teacher R stresses that students learn best by "*doing the activities and experiments by themselves*." Additionally, approximately 45% of the respondents held responsive beliefs, focusing on student engagement and interpretation of phenomena. Teacher D highlights this approach: "*My students learn science best through observation and dialogue*." At the same time, Teacher H believes learning is most effective when students engage in "*enjoyable activities where they share and present their results, outputs, thoughts, and ideas*."

No teachers in the study demonstrated traditional or instructive beliefs, where learning is teacher-centered or mimicking. One teacher, Teacher N, reflected reform-based beliefs, advocating for student-driven learning through diverse materials and activities, though this was not widely shared among respondents.

How do you know when learning is occurring in your science classroom?

Around 45% of the teachers in this study demonstrated responsive beliefs, where learning is perceived as occurring when students actively engage with peers or the teacher on the topic. Teacher H exemplifies this, stating that learning occurs "*when there is active participation between the teacher and my students and/or among the students themselves*."

Similarly, Teacher V believes learning occurs when "*students are engaged actively in the teaching and learning process*." None of the teachers exhibited traditional beliefs, where learning is gauged by observing student behavior, such as attention or order. Some teachers, like Teacher C and Teacher W, held instructive beliefs, asserting that learning is evident when students can follow instructions and demonstrate mastery. Teacher C noted that "*learning has occurred when the students have mastered the lesson through their scores*." Teachers with transitional beliefs, such as Teacher B, perceive learning based on student reactions, stating, "*Learning occurs in class when students start to react.*" Teacher I combines cognitive and affective aspects, saying, "*Academic noise, maximum participation in class, high assessment results, enthusiasm, and interest signals that learning is taking place.*" Lastly, reform-based beliefs, held by teachers like Teacher D and Teacher G, emphasize learning when students ask questions and show curiosity.

Secondary School Teachers' Scientific Epistemological Beliefs (SEBs)

The teachers' SEBs were determined to identify the prevailing beliefs of the teachers about the nature of science (NOS). Table 2 shows the classification of teachers based on their beliefs, which are manifested in their responses in the SEBQ.

SEB Classifications	*N*	Percentage
Traditional	5	9.26
Fairly Traditional	32	59.26
Fairly Contemporary	11	20.37
Contemporary	6	11.11
Total	54	100.00

Table 2: Teacher Classification Based on Their Scientific Epistemological Beliefs

Table 2 shows that most teachers are classified as fairly traditional (59.26%), meaning that more than half of the respondents still disagree with the constructivists' belief in scientific epistemologies. In contrast, a combined portion of teachers (fairly contemporary and contemporary) embrace more modern and evolving scientific knowledge perspectives and somehow accept science's dynamic and revolutionary nature. The distribution highlights the variability in teachers' epistemological beliefs within the sample, emphasizing the need for tailored approaches to pedagogy and professional development initiatives to consider and address this diversity to enhance science education practices. The question of why most teachers possess fairly traditional scientific epistemological beliefs still needs to be answered and understood.

Profile Variables	*N*	Mean SEB	SD	SEB
Age				
20 to 30 years old	16	2.45	.078	Fairly Traditional
31 to 40 years old	12	2.49	.085	Fairly Traditional
41 to 50 years old	17	2.44	.128	Fairly Traditional
51 years and above	9	2.54	.065	Fairly Contemporary
Number of Years Teaching Science				
1 to 5 years	16	2.38	.103	Fairly Traditional
6 to 10 years	11	2.44	.035	Fairly Traditional
11 to 15 years	12	2.49	.092	Fairly Traditional
16 to 20 years	8	2.47	.158	Fairly Traditional
21 years and above	7	2.50	.098	Fairly Contemporary
Field of Specialization				
General Science	17	2.46	.218	Fairly Traditional
Physical science	10	2.45	.054	Fairly Traditional
Biology	12	2.47	.212	Fairly Traditional
Chemistry	8	2.48	.051	Fairly Traditional
Physics	7	2.55	.053	Fairly Contemporary
Highest Educational Attainment				
Bachelor's Degree	41	2.47	.133	Fairly Traditional
Master's Degree	13	2.42	.025	Fairly Traditional

Table 3: Scientific Epistemological Beliefs of Teachers Based on Their Profile Variables

The SEB of the teachers, when grouped according to their profile variables, is also determined. Table 3 shows that those teachers who are 51 years old and above hold fairly contemporary beliefs of science epistemologies, while those who are 50 and below exhibit fairly traditional beliefs. Those who are teaching science, ranging from 21 and above, exhibit fairly contemporary beliefs. On specialization, those who specialized in physics show fairly contemporary SEBs. On the other hand, those who specialized in physical science, biology, general science, and chemistry exhibited fairly traditional beliefs.

On teachers' educational attainment, both bachelor's and master's degree holders hold fairly traditional SEB.

To further explain the teachers' SEB results, their correlation with the different profile variables was determined. Pearson's r and Spearman's rho (r_s) correlation coefficients were identified to explore which profile variable correlates with teachers' SEB.

Teacher Profile	r_s	p	Correlation Strength
Age[r]	0.420*	.013	Moderate
No. of Years Teaching Science	0.486*	.015	Moderate
Specialization	0.255	.143	Very weak
Highest Educational Attainment	-0.158	.335	Very weak

Table 4: Correlation Between Teachers' Scientific Epistemological Beliefs and Their Profile Variables

Table 4 shows that specialization and educational attainment did not show a significant correlation with teachers' SEB. This suggests that these profile variables are not necessarily related to teachers' beliefs about the nature of scientific knowledge. Of the profile variables identified, age (r = .420, p = .013) and the number of years in teaching science (r_s = 0.486, p_x = 0.015) show a significant correlation with teachers' SEB. The findings suggest both a positive and moderate correlation, which implies that the longer the time spent teaching science and the older the teacher is, the higher the tendency to develop a more contemporary belief in scientific knowledge. On the other hand, younger and novice teachers tend to show more traditional beliefs in science epistemologies.

The mean for each scientific belief dimension was computed and described in Table 5 to determine the overall depth of teachers' understanding of scientific epistemologies.

Scientific Epistemology	N	Mean	SD	Qualitative Description
Role and Images of Scientists	54	2.687	0.328	Fairly Contemporary
Scientific Knowledge	54	2.529	0.136	Fairly Contemporary
Scientific Method	54	2.243	0.204	Fairly Traditional
Scientific Law	54	2.243	0.342	Fairly Traditional
Overall SEB	54	2.445	0.114	Fairly Traditional

Table 5: Secondary School Teachers' General Scientific Epistemological Beliefs (SEBs)

Table 5 shows that teachers' beliefs on the role and images of scientists (M = 2.687, SD = 0.328) and scientific knowledge (M = 2.529, SD = 0.136) are fairly contemporary. On the other hand, their beliefs on both the scientific method (M = 2.243, SD = 0.204) and scientific law (M = 2.243, SD = 0.342) are fairly traditional. Their overall SEB (M = 2.445, SD = 0.114) was categorized as fairly traditional, suggesting that the teachers may not fully embrace the dynamic nature of science in their educational philosophy.

Secondary School Teachers' Approaches to Teaching

Teachers' approaches to teaching were also determined. Table 6 shows the number of teachers using the different teaching approaches.

Approaches to Teaching	Frequency	Percent
Approach A: Knowledge transmission	0	0
Approach B: Knowledge acquisition	7	12.96
Approach C: Transitional Stage	32	59.26
Approach D: Conceptual Development	15	27.78
Approach E: Conceptual Change	0	0
Total	54	100.0

Table 6: Classification of Secondary School Teachers' Approaches to Teaching

Scores fall within the range of approaches B to D, with most teachers (59.26%) falling into the transitional category. This suggests that most teachers employ a combination of teacher- and student-focused strategies, which aim for students to grasp the concepts of the discipline. Around a quarter (27.78%) are adopting conceptual development approaches, focusing on nurturing students' understanding of science. Nevertheless, 12.96% still rely on knowledge acquisition teaching methods. No teacher falls into the knowledge transmission category, and none scored high enough to be classified under the conceptual change category.

Correlation of Teachers' Scientific Epistemological Beliefs and their Teaching Approaches

Table 7 shows the correlation between teachers' scientific epistemological beliefs and the components of their teaching approaches.

Teachers' SEB	*r*	*p*	Significance	Correlation Strength
Role and Images of Scientists	.146	.460	Not significant	Very Weak
Scientific Knowledge and Theory	.550*	.002	Significant	Moderate
Scientific Method	.244	.211	Not significant	Weak
Scientific Law	-.120	.544	Not significant	Very Weak
Teachers' Mean SEB	.404*	.033	Significant	Moderate

Table 7: Significant Correlation between Teachers' Scientific Epistemological Beliefs and their Teaching Approaches

As shown in Table 7, only two components of SEB – scientific knowledge and theory and the mean SEB – showed statistically significant correlations with teaching approaches. The belief in scientific knowledge and theory has a moderate positive correlation (r = 0.550, p = 0.002), suggesting that teachers with more contemporary views on science tend to adopt more conceptual development and change-based teaching approaches. Additionally, the overall mean SEB showed a moderate and significant correlation (r = 0.404, p = 0.033), indicating that a teacher's broader scientific beliefs are linked to their choice of teaching method. However, none of the other SEB components – such as the role and images of scientists, scientific method, or scientific law – demonstrated significant correlations with teaching approaches. These results highlight the complex nature of how scientific beliefs influence teaching practices and suggest that, while certain beliefs may be associated with specific teaching strategies, the connections are not uniform across all SEB components. However, it is important to approach these findings cautiously, and further research could help clarify the nuances of these relationships. Future quantitative studies may be conducted to confirm these findings.

DISCUSSION

Integration of Qualitative and Quantitative Data on Teaching Beliefs, Teachers' Epistemological Beliefs and Approaches to Teaching

The analysis of both qualitative and quantitative findings revealed both convergence and discordance in the results. Interviews indicated that while science teachers hold exceptionally positive beliefs about reform-based teaching, they are often impeded from enacting these beliefs due to the current educational policies in the country. Implementing reform-based principles and standards, including changes to science assessment, could provide the necessary impetus to bridge the gap between beliefs and practices in science education. However, this study revealed that not all teachers' beliefs translate into classroom practices. While most teachers believe in reform-based teaching roles, many default to traditional methods when deciding what to teach, highlighting significant barriers.

The discordance appears to be influenced by the Department of Education's policies, particularly the mandate that "competencies are non-negotiable." Such policies may hinder the adoption of 'productive pedagogies' that emphasize real-world connections and investigative learning. The focus on standardized testing, such as the National Achievement Test (NAT), often compels educators to prioritize high test scores over fostering critical thinking or encouraging deeper exploration of ideas. This policy-driven tension between reform-oriented beliefs and traditional practices is a growing concern, especially in science education.

To address these inconsistencies, school administrators should support teachers in creatively navigating these constraints and adopting strategies to align their practices with their beliefs. Additionally, the Department of Education and other relevant authorities should consider minimizing these barriers by shifting the educational system's focus from examination-oriented outcomes to learning-oriented goals. This shift would empower teachers to embrace innovative, reform-based approaches and enhance the quality of science education.

Regarding the teachers' scientific epistemological beliefs, the findings of this study indicate that, despite teaching in a 21st-century setting, their views on science epistemology still align with a positivist perspective. The results confirm previous studies on science teachers' understanding of NOS (García and Sebastian, 2011; Lederman, 2013; Liang et al., 2009; and Tsai, 2007). Results reflect, unfortunately, naïve patterns of epistemological beliefs similar to those that had been observed in previous years, such as those of Abd-El-Khalick and Lederman (2000), Lederman (1992), and Nott and Wellington (1993). The results imply that for these past decades, conceptions of scientific epistemologies have still not elevated from the traditional perspectives and conceptions of the NOS.

There is a prevailing assumption that older teachers tend to adhere more to traditional teaching approaches than newer ones. However, the findings of the present study challenge this notion. Younger teachers have demonstrated more traditional beliefs than older ones. It is suggested that these results may be attributed to the length of time teachers have been exposed to teaching science and its concepts rather than simply age. Older teachers have likely encountered more changes in scientific concepts and advancements over their careers than newer teachers. Additionally, experienced educators have often participated in various professional development opportunities such as training, seminars, and workshops, which may have contributed to refining their beliefs regarding the epistemological foundations of scientific knowledge. They have likely witnessed first-hand the dynamic nature of scientific knowledge, understanding that what was taught years ago may have evolved or even been disproven by current scientific understanding. In contrast, newer or novices may still hold more idealistic views about their teaching practices, as they have yet to accumulate the same level of experience and exposure to the ever-changing landscape of science education. Their possible lack of exposure to the evolution of scientific knowledge may lead them to view science education as more static or idealized than it truly is. Educators' beliefs about knowledge, content, and curriculum are shaped by repeated teaching experiences (Kim and Hannafin, 2008). Without an extensive "case library" to draw from, Novice teachers may struggle to form their own beliefs about science and its

teaching. Experience helps teachers develop a set of beliefs that influence their instructional practices. This aligns with Hofer and Pintrich's (1997) observation of a positive correlation between age and epistemological development, though the exact starting point of this development remains unclear.

Numerous studies have highlighted science teachers' inadequate comprehension of scientific epistemologies. The result of this study, for example, lends support to the claims of Celik and Bayrakçeken (2006), Irez (2006), and Yalvac et al. (2007) who found out that science teachers, in general, hold mythical anthropocentric and instrumentalist beliefs of science, such as that technology is an application of science, that science describes nature, or that science provides material benefits. The results of the interviews (qualitative) and surveys (quantitative) show that science teachers have not managed to accept the subjective components of science or the tentative and provisional nature of scientific knowledge that emerges from the scientific community. Similarly, they do not understand the differences among scientific theories, laws, and hypotheses, the characteristics of the scientific method, and the different status of observations, inferences, and empirical evidence.

The present study's findings show that most teachers are still in the transitional stage between traditional and contemporary teaching approaches. These results support Madronio's findings (2015) regarding teachers' use of various instructional strategies and methods in Nueva Vizcaya, Philippines. Teachers use a combination of traditional methods and outcome-based teaching and learning methods. This may have been a consequence of what appeared in the interview with regard to their teaching beliefs. Science teachers across the province hold optimistic views regarding reform-based teaching methodologies. However, existing educational policies within the country hinder their ability to implement these innovative approaches in the classroom. The findings align with Smith (2010), who highlighted the prevalence of lecture-based instruction, with survey respondents ranking simulation activities and one-on-one discussions as highly effective. This echoes Qablan et al. (2010) and Al-Amoush et al. (2014), who found entrenched teacher-centered beliefs among Jordanian primary and secondary school teachers, respectively. The present study's results parallel those of Lindblad and Sahlstrom (2001), who observed a shift towards increased student engagement in classroom discourse and reduced reliance on whole-class teaching over two decades ago. However, the current study suggests that teachers have not significantly progressed from the transition between traditional and contemporary teaching approaches since then, indicating a persistent reliance on traditional methods.

The results of the present study highlight a positive correlation between teachers' approaches to teaching and their scientific epistemological beliefs (SEBs), reflecting the influence of constructivist beliefs on contemporary views of scientific knowledge. Constructivist teachers emphasize active student participation and the co-construction of understanding, which directly shapes their instructional planning and strategies. These findings align with several studies conducted by other researchers. For instance, Yildizli (2019) suggests that teachers' beliefs about their teaching objectives are critical factors influencing instructional practices. Teachers who view science as static tend to rely on textbook instructions and prioritize correct answers, whereas those who see science as evolving are more likely to foster student discussions (Brickhouse, 1990). Schraw and Olafson (2002) emphasize that teachers' epistemological beliefs strongly influence instructional decisions. Further research indicates a positive correlation between teachers' SEBs and their instructional approaches (Tsai, 2002) as well as student learning outcomes (Polly et al., 2013). Additionally, teachers who perceive scientific knowledge as fixed are more inclined to use transmissionist methods, while those who view it as tentative tend to adopt constructivist approaches (Chai et al., 2010).

More recent research indicates that teachers' choice of teaching methods is strongly influenced by their epistemic beliefs (EBs). Teachers' ontological and epistemological beliefs significantly impact their teaching approaches, particularly in inquiry-based settings (Kelly, 2021), their choice of constructivist teaching methods (Uslu, 2018), and their predominant teaching style (Soleimani, 2020), though teachers' EBs may be resistant to change (Küçükaydin & Gökbulut, 2020). Moreover, EBs are vital in shaping attitudes toward education research (Guilfoyle et al., 2020) and scientific literacy (Vieira et al., 2017). Guo et al. (2022) further support this notion, indicating that adaptive epistemic beliefs are associated with higher science motivation, achievement, and career aspirations. Yucel (2018) provides a different perspective, highlighting the intricate interplay between scientists' ontological and epistemological views and advocating for a balanced approach to science education. Hence, it is deemed significant to reevaluate the role of scientific epistemological beliefs in science education and their impact on attitudes, motivation, and achievement.

Implications

Identifying specific individual beliefs may lead to better comprehension of belief frameworks in general and their often integral inconsistencies and contradictions. A comprehension of an individual's beliefs can help with the design and advancement of professional advancement sessions.

The results of this study suggest several potential avenues for improving teacher education in the country. These include a review of the science teacher education curriculum, increased self-assessment of science teachers' beliefs, amplified communication among science educators, and a more frequent update regarding the changes in the existing scientific knowledge. Teachers' scientific epistemic beliefs were found to be significantly correlated with their teaching approaches. With this relationship, the importance of developing teachers' sets of beliefs and taking into account these beliefs when designing professional development programs for teachers should always be regarded as a point for consideration. A separate course focused on the philosophy and nature of science should be offered in the teacher education programs (undergraduate, master's, and doctorate degrees) in the country to inform the teachers of the very nature of epistemologies and origins of science knowledge. This is to reform, redirect, and reconstruct teachers' set of beliefs about the true nature of scientific knowledge.

Therefore, this study's results call for curriculum developers to include the NOS in the pre-service teachers' curriculum. It is usually acknowledged that teachers' pedagogical actions are guided overall by their general conceptions of teaching and learning, and these conceptions, in turn, depend on the teachers' developmental stage (Mellado, 1998; Abd-El-Khalick, 2006; Lederman, 2013). Hence, including NOS and scientific epistemologies in the curriculum is encouraged.

Teachers' conceptions of the nature of science (NOS) play a vital role in science education, not only due to NOS's significance in scientific literacy but also because these conceptions shape instructional practices and curriculum decisions (DeBoer, 2000; Lederman, 2013; Millar, 2006). Research indicates that student teachers bring with them beliefs about teaching and learning from prior experiences, which influence their perceptions of relevance and usefulness during teacher education courses (Goodman, 1988; Markic and Eilks, 2008; Smith, 2005). To foster change and overcome traditional beliefs, teacher education programs must provide relevant information, appropriate pedagogies, and personal experiences (Choi and Ramsey, 2010). Recognizing and understanding teachers' beliefs is crucial for enhancing teacher education programs and facilitating pre-service teachers' personal learning and professional development (Bryan, 2003; Bursal, 2010; Putnam and Borko, 1997). Similarly, acknowledging teachers' beliefs is increasingly recognized as essential during educational reforms (Justi and Van Driel, 2006).

All teachers operate based on a personal theory of teaching, influencing instructional choices, classroom management practices, and curriculum translation (Luft and Roehrig, 2007; Önen, 2011; Pajares, 1992; Shinde and Karekatti, 2012; Splitter, 2010). These beliefs are often implicit, with teachers unaware of their influence on behavior (Patrick and Pintrich, 2001). Consequently, teachers' beliefs affect educational innovation and reform programs (Johnson, 2006; Milner et al., 2012; Van Driel et al., 2007). Educational reform initiatives rely heavily on teachers' beliefs, which are less malleable than knowledge systems, making them essential for the success of reforms (Oppell and Aldridge, 2015). As Keys and Bryan (2001) claimed, each element of the teaching process is formed by and framed from teachers' epistemic beliefs (EBs). Hence, with a reformed set of epistemic beliefs, choices of strategies and teaching approaches might improve, which, in turn, could lead to improved and enhanced scientific literacy in the country.

CONCLUSION

Teachers' interview responses highlight a wide spectrum of instructional beliefs, with instructive and transitional orientations particularly prominent. The majority of science teachers prefer fairly traditional scientific epistemological beliefs, indicating that teachers in the province adhere to conventional perspectives regarding the origin and characteristics of scientific knowledge. Most of these teachers utilize transitional approaches to teaching science. Additionally, there are noteworthy correlations between teachers' teaching approaches and their scientific epistemological beliefs, indicating a relationship between instructional methods and underlying views on the nature of scientific knowledge. The results also provide quantitative evidence that teachers' set of scientific epistemological beliefs relate to their choice of student-centered or learner-focused teaching approaches, suggesting that those who hold naïve conceptions about the real nature of science tend to use information transfer/teacher-focused approaches to teaching. In contrast, those who hold sophisticated beliefs about the nature of science or those who believe in the tentative nature of scientific knowledge tend to use conceptual change/student-focused approaches to teaching science.

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Full research paper

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

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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

Project management, Profile of Mood States, Scrum, serious management game, teaching methods

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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 Núnez (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).

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

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.

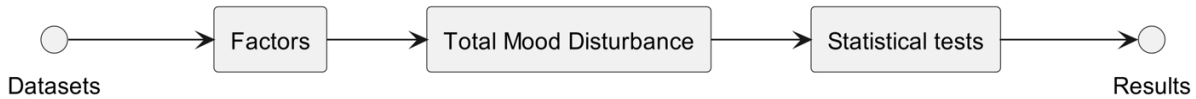

Figure 2: Statistical analysis (source: own)

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.

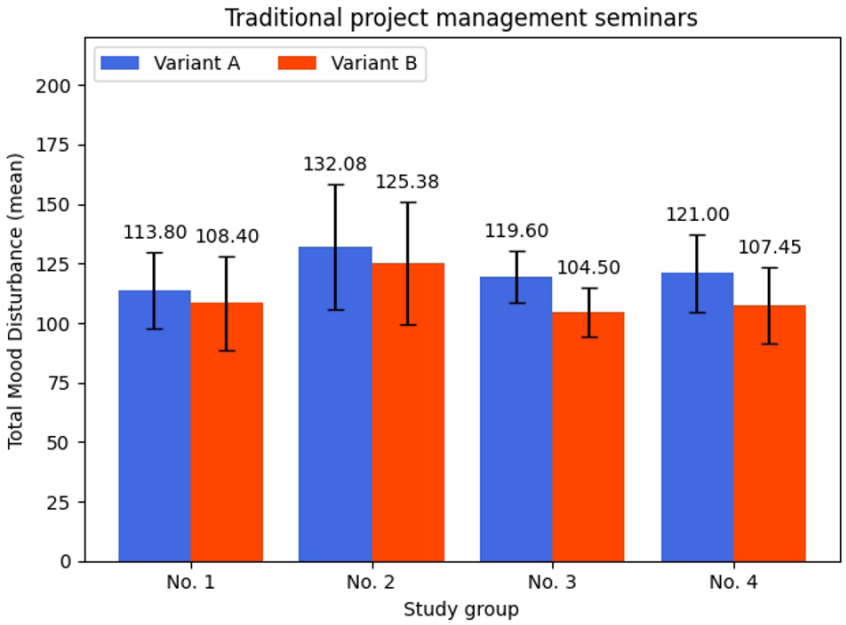

Figure 3: Total Mood Disturbance in Traditional Project Management Seminars (source: own calculation)

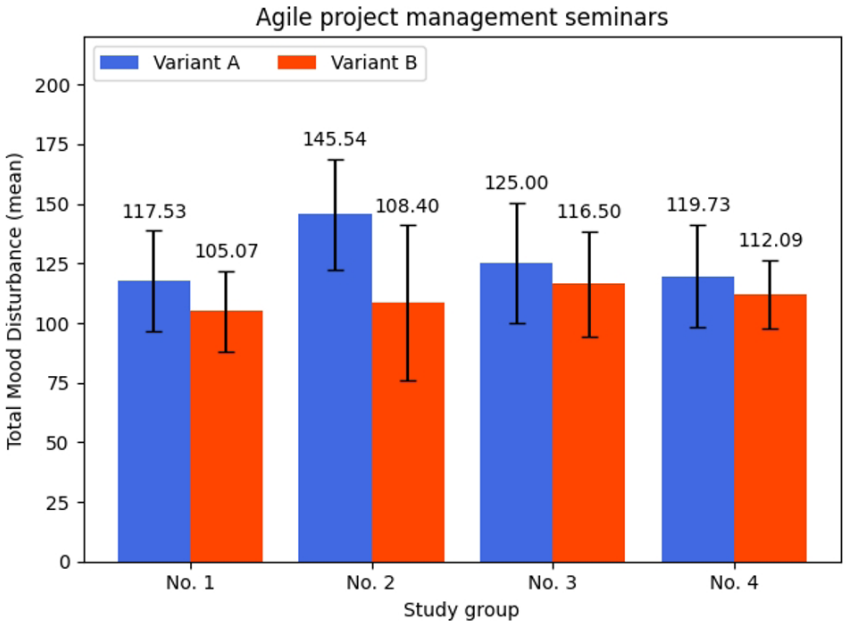

Figure 4: Total Mood Disturbance in Agile Project Management Seminars (source: own calculation)

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.

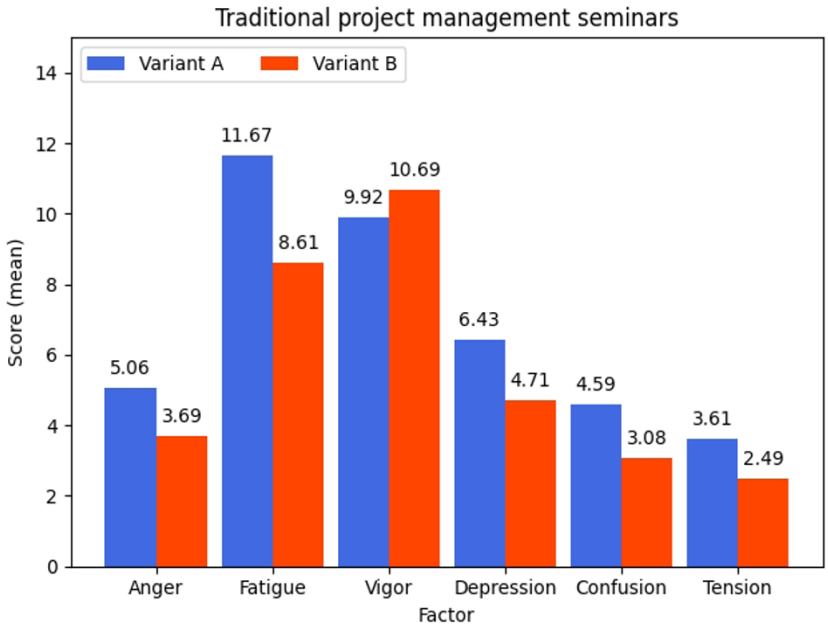

Figure 5: Factor Scores for Traditional Project Management Seminars (source: own calculation)

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

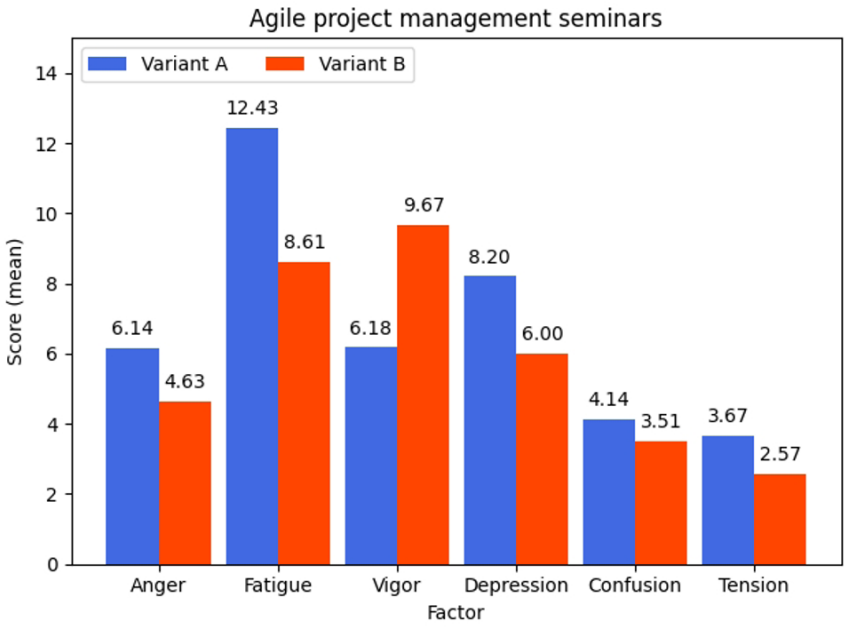

Figure 6: Factor Scores for Agile Project Management Seminars (source: own calculation)

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,

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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APPENDIX

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)

STUDENTS' ATTITUDES TOWARD THE ANNUAL INSTRUMENTAL EXAM IN CROATIAN ELEMENTARY MUSIC SCHOOLS

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ABSTRACT

At the end of the school year, the music schools organize the annual instrumental exam to evaluate the student's achievements. The study investigates complex patterns of performance anxiety in music school students during annual exams, focusing on how gender, age, instrument type, and family musical tradition interact, revealing inconsistencies with prior research and illustrating the importance of tailored pedagogical interventions. The study was conducted on a sample of 143 third- to sixth-grade students, using a 14-item Likert-scale questionnaire. Results show high levels of pre-exam stress, especially among girls and piano students, while younger students reported more positive emotions before the exam and older students were calmer afterward. Family music tradition had limited influence. These findings underscore the need to rethink evaluation approaches in music education with an emphasis on students' emotional well-being. Teachers and parents must create a supportive and positive environment before and during the exam, particularly for girls. The study also has practical implications: it emphasizes that there must be psychological preparation for exams, emotional intelligence development, and consideration of alternative assessment methods that reduce stress.

KEYWORDS

Annual instrumental exam, efficiency in educational policies, elementary music school, evaluation and assessment, students' attitudes

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Highlights

- *After the annual instrumental exam, the students feel relieved, happy, and calm.*
- *Girls experience headaches, tremors, nausea or stomach discomfort, faster heartbeat, and stress before the annual instrumental exam compared to boys.*
- *Instrumental teachers and parents should ensure a supportive and positive atmosphere before and during the annual instrumental exam.*
- *This research contributes to a more profound understanding of the psychological dimensions of music education and offers a foundation for developing sensitivity and efficiency in educational policies.*

INTRODUCTION

In addition to elementary general education, music schools in Croatia offer music studies (MSES, 2006). These teaching methods include individual and group lessons, where individual lessons focus on teaching a specific instrument, while group lessons focus on teaching group musicianship and music theory subjects. In individual instrument lessons, it is crucial for students to feel comfortable. Sabljar (2019) argues that the unique teacher-student dynamic in these lessons demands significant emotional investment, fostering an exceptionally close relationship between participants. Roden et al. (2021) point out that the lack of positive emotions or the appearance of negative emotions plays an important role in learning to play an instrument, i.e., negative emotions can lead to giving up playing the instrument and practicing music. Osborne et al. (2016) investigated the emotional qualities and social factors important for a student's decision to continue or stop playing an instrument. They discovered that several factors influence this decision: a) the musical repertoire the student practices; b) the presence of an instrument-playing family member or friend; c) the presence of positive support from family, teachers, and peers for practicing and playing the instrument;

d) the student's enjoyment of playing the instrument; and e) various self-regulation strategies that aid in the student's improvement.

Evaluation in Instrumental Teaching

The primary objective of music education in music schools in Croatia extends beyond mere grading to emphasize the learning process. Consequently, effective evaluation requires teachers to assess each student's progress in terms of their capabilities rather than through comparison with peers (MSE, 2017). The examination committee in music schools conducts evaluations at public and internal performances and annual exams, while the professional committees of music schools determine the methods and elements of evaluation (MSE, 2019). Such an arrangement means that teachers independently develop criteria for student evaluation. Matoš (2018), Brđanović (2017; 2012), and Rojko (2006) propose guidelines for refining the current curriculum according to which instrument teaching is carried out in Croatian music schools. Therefore, Matoš (2018) believes that it is necessary to create subject curricula based on learning outcomes and adopt criteria for evaluating students according to the defined outcomes. Brđanović (2017) also points out that evaluation criteria can be a source of errors when evaluating someone's playing and interpretation due to the dilemma of what the criterion is, i.e., due to the subjective experience seen and heard by each examination committee member. Therefore, the criteria for such an evaluation should, at least in the part where it is possible, be elaborated and agreed upon (Brđanović, 2012).

Brđanović (2017) also believes that evaluation criteria and rules should be specified in the curricula to reduce the stress of the evaluation process and that a more comprehensive evaluation method is needed to increase the metric and prognostic value of the evaluation. Namely, Brđanović (2017) points out that the numerical grading does not provide complete information regarding one's playing competences and that it needs to be supplemented with a descriptive grading, which, on a standardized sheet, would give a more detailed and objective insight into the musical peculiarities of the student. He also believes that the numerical evaluation does not lose its importance but that, as an element of grading, it remains an integral part of the evaluation. Matoš (2018) points out that the evaluation of students' achievements in music schools should be based on different evaluation methods, and the final grade should not be based only on the summative assessment by the committee after the exam. In music schools, a committee exam determines the final grade for all subjects, including playing an instrument, at the end of the school year. The committee consists of the subject teacher who worked with the student during the school year and other teachers of the same instrument. The final annual grade is the average of the subject teacher's grade for the student's performance during the year and the performance grade obtained from each member of the committee.

Rojko (2006) criticizes the overemphasis on a limited number of exam compositions, leading students to practice the exam program for several months while neglecting the other compositions. Nevertheless, annual instrumental exams in music schools are a reality for which teachers and students prepare throughout the year, and the exam concludes the one-year monitoring of students' work and progress (Brđanović, 2012). Brđanović (2017) highlights that evaluating not all students of the same instrument by the same committee can lead to insufficient reliability and objectivity. In addition, the exam grade gives very little information regarding the student's playing competence: it does not enable a valid forecast of his further development; it does not say anything regarding the way and speed of learning, precision, independence in work, or understanding of music. Therefore, the research results by Brđanović (2017) are not surprising, which indicated that almost two-thirds of the instrumental teachers surveyed, i.e., 59.41%, believe that the current way of evaluating playing is not sufficiently objective.

Grading depends on many factors, including the teacher, the student, and the testing and grading methods. Lavrnja (1998) points out that a teacher's style (whether easygoing or strict) and various biases, like the halo effect and different types of errors, can affect how they grade students. The student's verbal abilities, ability to observe the teacher's reactions, skillful use of perceived data, and emotional (in)stability impact the grade. The observation above indicates that emotions emerge during evaluation, serving as a supporting element in the learning process and its associated activities. Certain emotions, like fear, can hinder learning. On the other hand, pleasant emotions such as curiosity, enthusiasm, and joy contribute to the learning process and make it more successful (Tan et al., 2021; Bognar and Dubovicki, 2012). Given that the topic of this paper pertains to the annual instrumental exam, we will emphasize the crucial role emotions play in ensuring successful lessons.

Performance Anxiety – Causes, Patterns, and Pedagogical Implications

Emotions are certainly present during student evaluation and assessment, but they are also visible during public performances, i.e., concerts, which are an important part of music education. Public performances also represent a form of evaluation and assessment by the audience. Public performance can lead to positive or negative emotions in performers (Aydın and İşgörür, 2017). Music students experience a complex array of emotions – including hope, joy, anxiety, and excitement – before and during evaluations, with ambivalent states (intertwined positive and negative feelings) particularly prevalent immediately before performances (Kaleńska-Rodzaj, 2018). Given this emotional complexity, Wen (2022) points out the importance of instrumental teachers in fostering students' intrinsic motivation and positive affect. When students develop a genuine interest in their learning, their purpose shifts toward intellectual curiosity, fueling sustained motivation, enthusiasm, and perseverance. Performance self-confidence is vital, as musicians must project assurance and present their best selves to audiences. This aligns with Zdravić-Mihailović's (2021) emphasis on teacher-provided emotional support to mitigate performance anxiety. Students who perceive strong teacher support demonstrate greater onstage confidence, illustrating how positive teacher-student relationships function as a stress buffer during high-pressure evaluations.

The exam, like any public performance, is, to a certain extent, a stressful experience in which nervousness occurs due to the fear of failure (Brđanović, 2012). When students perform in front of a committee during final exams, they may display mental, physical, emotional, and reactive symptoms fueled by anxiety. This anxiety stems from the fear of making mistakes or the committee's disapproval of their performance. Fear can also occur during stage performances, although no real evaluation exists (Umuzdaş et al., 2019). Research specifically reveals that a third of participants experience anxiety during a public performance (Papageorgi, 2021). As a result, we can conclude that fear occurs not only during public performances, i.e., concerts but also during the annual instrumental exam. Research reveals complex, age-related patterns in music performance anxiety (MPA). Umuzdaş et al. (2019) found that first-year instrumental students had higher anxiety levels (45%), while Kılıç (2018) found that final-year students experienced the most anxiety (over 60%), indicating that different stages of education and development can lead to different levels of stress. A study (Patston & Osborne, 2016) shows that musical performance ability becomes stable after age 16 with regular practice while starting music lessons early (before age 7) helps lower stress by 25% (Zarza-Alzugaray et al., 2016). These contrasting findings highlight how institutional, developmental, and experiential factors interact to shape anxiety profiles.

Britsch's (2005) research revealed that up to 75% of adolescent students experience anxiety (trembling hands, dry mouth, and rapid heart rate) during public playing. Shoup (1995) found that anxiety due to public performance is present to a somewhat lesser extent, i.e., in 55% of high school instrument students. According to Fehm and Schmidt (2006), anxiety while playing at public performances is less prevalent, i.e., in a third of adolescents. Dempsey and Comeau (2019) compared the anxiety of children (aged 7 to 12) and adolescents (aged 13 to 17) during a musical performance. They determined that the level of anxiety increases with age, i.e., adolescents experience a significantly higher level of anxiety. Sokoli et al. (2022) found that anxiety increases until middle age and then decreases in late adulthood. Ryan (1998) found that, although public performance anxiety was present in all 12-year-old piano students, perceived nervousness and increased heart rate did not affect playing quality. Zarza-Alzugaray et al. (2016) found that starting music education at seven or earlier can protect music school students from public performance anxiety. Research conducted by Czajkowski et al. (2020) showed that an 8-week mindfulness program reduced anxiety by 35%.

Umuzdaş et al. (2019) conducted research among undergraduate instrument students and found that individuals with higher levels of anxiety in everyday life also experience greater anxiety during exams. Regarding gender, research (Umuzdaş et al., 2019; Baydağ and Alpagut, 2016; Topoğlu, 2014) found that female students have higher anxiety than male students. This gender disparity in performance anxiety aligns with large-scale evidence from Sokoli et al. (2022), whose study of 1.200 professional musicians revealed that 62% of female musicians experience frequent anxiety compared to 38% of male counterparts – a nearly 2:1 ratio that mirrors our findings in student populations. Research has shown that girls and adult women experience higher levels of anxiety during public music performances compared to boys and adult men (Sokoli et al., 2022; Patston and Osborne, 2016; Thomas and Nettelbeck, 2014; Papageorgi et al., 2013; Kenny and Osborne, 2006; Rae and McCambridge, 2004). However, research conducted by Küçük (2010), Kılıç (2018), and Yokuş et al. (2013) determined that there is no difference in anxiety regarding gender.

Umuzdaş et al. (2019) found that students who play string instruments experience higher levels of anxiety, regardless of the instrument they play. Iusca and Dafinoiu's (2012) research demonstrated that students who play string instruments experience higher levels of anxiety compared to those who play piano or wind instruments. However, Sokoli et al. (2022) found that instrumentalists who play wind instruments during public performances have significantly more problems, such as difficulty breathing, dry mouth, and dry throat, while piano players and those who play string instruments have problems with fine motor skills of the fingers. The same study found that violinists (58%) and flutists (55%) had the most symptoms, while pianists (48%) showed more problems with finger motor skills (60%).

Kaleńska-Rodzaj's (2018) study of adolescent violinists (aged 13-21) revealed the paradoxical coexistence of positive and negative pre-performance emotions. While 93% reported dominant sadness (with 80% experiencing associated depression and despondency), 78% simultaneously felt positive affect – including cheerfulness, optimism, and energetic arousal. Notably, over 50% endorsed stress-related emotions, illustrating the complex ambivalence of performance states. These findings prompted Kaleńska-Rodzaj (2020) to conceptualize music performance anxiety as a multidimensional phenomenon requiring (1) emotional intelligence training to navigate mixed states, (2) evidence-based regulation techniques (e.g., mindfulness, visualization), and (3) personalized interventions tailored to musicians' psychological profiles.

The aforementioned research motivated this study. The study investigates complex patterns of performance anxiety in music school students during annual exams, focusing on how gender, age, instrument type, and family musical tradition interact. It reveals inconsistencies with prior research and points out the importance of tailored pedagogical interventions.

Research Goal and Hypothesis

Based on the existing issues in evaluating students in final exams and their negative impact, this paper aims to examine the attitudes of elementary music school students toward the annual instrumental exam, as well as potential differences regarding gender, grade, family musical tradition, and the instrument they play, to highlight the need to address these concerns more thoroughly. For this reason, and based on previous research (Sokoli et al., 2022; Umuzdaş et al., 2019; Dempsey and Comeau, 2019; Kılıç, 2018; Baydağ and Alpagut, 2016; Patston and Osborne, 2016; Topoğlu, 2014; Thomas and Nettelbeck, 2014; Iusca and Dafinoiu, 2012; Shoup, 1995), we formulated the following hypotheses:

- H1: There is a statistically significant difference between students' attitudes regarding the annual instrumental exam and gender.
- H2: There is a statistically significant difference between students' attitudes regarding the annual instrumental exam and grades.
- H3: There is a statistically significant difference between students' attitudes regarding the annual instrumental exam and the instrument they play.
- H4: There is a statistically significant difference between students' attitudes regarding the annual instrumental exam and musical tradition in the family.

MATERIALS AND METHODS

Study Participants

The research occurred during the 2023–2024 school year and included 143 students (ages 11 to 14) from the third to sixth grades of public elementary music schools in Croatia. Of the participants, 54 were boys and 89 were girls. Regarding grade distribution, 46.9% of students were from lower grades (3rd and 4th), while 53.1% were from higher grades (5th and 6th). By age, the lower grades comprised 11- to 12-year-olds, and the higher grades comprised 13- to 14-year-olds. The largest group consisted of piano players (N = 63), which aligns with the fact that admission quotas for music schools are typically highest for this instrument. This cohort was followed by guitarists (N = 32) and tamburitza players (N = 20). The remaining 28 students played various other instruments, including flute, accordion, clarinet, saxophone, trumpet, percussion, viola, and cello, all represented significantly smaller numbers. Nearly two-thirds of respondents reported having musically engaged family members (Table 1). Written parental consent was requested and obtained to ensure compliance with ethical guidelines (Ajduković and Keresteš, 2020).

variable	categories	total (N = 143)
gender	male	54 (37.8%)
	female	89 (62.2%)
	total	143 (100.0%)
grade	lower (3rd and 4th)	67 (46.9%)
	higher (5th and 6th)	76 (53.1%)
	total	143 (100.0%)
instrument	guitar	32 (22.4%)
	Piano	63 (44.1%)
	tamburitza	20 (14.0%)
	other	28 (19.5%)
	total	143 (100.0%)
immediate family and music	yes	89 (62.2%)
	no	54 (37.8%)
	total	143 (100.0%)

Table 1: Sample structure by gender, grade level, instrument type, and family musical tradition (N = 143)

Research Instrument and Statistical Procedure

Music school teachers administered the anonymous printed questionnaire according to the authors' instructions, and completion took 7–10 minutes. The study was funded by the authors of this study. An anonymous questionnaire adapted from Sabolek (2023) was used to evaluate students' emotions before and after their annual instrumental exam. The questionnaire comprised 18 items, including questions and statements designed to assess their emotional responses. Students' attitudes were examined using a 14-item Likert scale instrument (e.g., on a scale from 1 to 5, indicate to what extent you agree with the statement: After the annual exam, I do not feel satisfied; 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree.). A Cronbach's alpha value of 0.710 confirmed the reliability of the instrument. We needed to use non-parametric tests because the Shapiro-Wilk test showed that all the variables we looked at were not normally distributed ($p < .001$). The Mann-Whitney U test was applied to test hypotheses and identify statistically significant differences in student attitudes. Quantitative data were processed using SPSS (Version 25).

RESULTS

The students agreed with 14 statements, which were used to determine their attitudes toward the annual instrumental exam (Table 2). Students reported neutral attitudes toward somatic symptoms of sweating (M = 2.90) and trembling (M = 2.90), suggesting these are common but not extreme stress responses. Similarly, ambivalence regarding abolishing exams (M = 2.99) reflects divergent attitudes, possibly tied to perceived exam value versus stress. Headaches (M = 2.40) and lack of air (M = 2.08) were less endorsed, indicating these are not predominant anxiety markers. Notably, pre-exam happiness was low (M = 2.48), aligning with anticipatory stress literature (Papageorgi et al., 2013). Stronger agreement with heart palpitations (M = 3.43) and general exam stress (M = 3.70) highlights clinically significant anxiety, consistent with performance studies (Kenny, 2011). Students reported pronounced relief (M = 4.58), happiness (M = 4.34), and calmness (M = 4.30), underscoring acute stress dissipation post-performance. However, residual dissatisfaction (M = 2.15) in a subset suggests grading or self-evaluation may influence outcomes. Neutral views on exam grade importance (M = 3.36) imply ambivalence regarding its weighting, warranting dialogue on assessment reform.

variable	M	SD
Before the annual instrumental exam, I am happy.	2.48	1.27
Before the annual instrumental exam, I have a headache.	2.40	1.45
Before the annual instrumental exam, I feel a lack of air.	2.08	1.39
Before the annual instrumental exam, I sweat.	2.90	1.59
Before the annual instrumental exam, I tremble.	2.90	1.50
Before the annual instrumental exam, I feel nauseous or uncomfortable in my stomach.	2.71	1.59
Before the annual instrumental exam, I feel my heart beating.	3.43	1.42
After the annual instrumental exam, I am relieved.	4.58	0.92
After the annual instrumental exam, I am happy.	4.34	1.09
After the annual instrumental exam, I am calm.	4.30	1.16
After the annual instrumental exam, I don't feel satisfied.	2.15	1.37
I think that the annual instrumental exam should be abolished.	2.99	1.49
The annual instrumental exam gives me stress.	3.70	1.34
The grade from the annual instrumental exam is more important to the final grade than the grades I get during the school year.	3.36	1.21

Table 2: Students' attitudes toward the annual instrumental exam (*N* = 143)

To test the set hypotheses, we compared the obtained data. The result obtained by the Mann-Whitney U test related to hypothesis H1: *There is a statistically significant difference between students' attitudes regarding the annual instrumental exam with regard to gender*, as Table 3 shows.

variable	male (*N* = 54) female (*N* = 89)	mean rank	Mann-Whitney U	*z*	*p*
Before the annual instrumental exam, I have a headache.	male	63.13	1924	-2.087	.037*
	female	77.38			
Before the annual instrumental exam, I tremble.	male	58.47	1672	-3.113	.002**
	female	80.21			
Before the annual instrumental exam, I feel nauseous or uncomfortable in my stomach.	male	61.39	1830	-2.467	.014*
	female	78.44			
Before the annual instrumental exam, I feel my heart beating.	male	61.61	1842	-2.403	.016*
	female	78.30			
The annual instrumental exam gives me stress.	male	60.64	1789	-2.662	.008*
	female	78.89			

Note: p < .05 p < .005***

Table 3: Differences in students' attitudes regarding gender obtained by the Mann-Whitney U test

variable	lower grades (*N* = 67) higher grades (*N* = 76)	mean rank	Mann-Whitney U	*z*	*p*
Before the annual instrumental exam, I am happy.	lower grades	80.94	1947	-2.495	.013*
	higher grades	64.12			
After the annual instrumental exam, I am calm.	lower grades	65.14	2086	-2.190	.028*
	higher grades	78.05			
The grade from the annual instrumental exam is more important to the final grade than the grades I get during the school year.	lower grades	79.69	1789	-2.805	.005*
	higher grades	60.39			

*Note: p < .05**

Table 4: Differences in students' attitudes regarding grades obtained by Mann-Whitney U test

The Mann-Whitney U tests did not reject H1. *There is a statistically significant difference between students' attitudes regarding the annual instrumental exam regarding gender*, revealing statistically significant gender differences in 5 of the 14 assessed variables ($p < .05$). The results demonstrate significant gender differences in experiencing exam stress. Female students reported significantly more frequent headaches before the exam compared to male students ($p = .037$). Additionally, female students experienced noticeably more trembling ($p = .002$), nausea or stomach discomfort ($p = .014$), and faster heartbeats ($p = .016$) before the exam. Furthermore, female students agreed more strongly with the statement that the annual exam causes stress ($p = .008$) than their male colleagues. These findings indicate that female music school students experience more pronounced physiological symptoms of anxiety and greater stress related to the annual exam

compared to male students. The difference was particularly noticeable in trembling, which showed the most marked gender difference.

To test the hypothesis H2 that *There is a statistically significant difference between students' attitudes regarding the annual instrumental exam with regard to grade*, the obtained results were compared (Table 4).

The Mann-Whitney U tests revealed statistically significant differences between lower (3rd–4th grade, $N = 67$) and higher (5th–6th grade, $N = 76$) grade students for three key variables ($p < .05$). Younger students reported significantly greater happiness before the exam ($p = .013$). Older students exhibited higher calmness after the exam ($p = .028$). Younger students agreed that the annual exam grade outweighs school-year grades ($p = .005$). Considering the obtained results, hypothesis H2, *a statistically significant difference exists between students' attitudes regarding the annual instrumental exam and grades* not being rejected.

With the purpose of testing hypothesis H3, *There is a statistically significant difference between students in their attitudes regarding the annual instrumental exam and the instrument they play*; the Mann-Whitney U test was used (Table 5). To compare the obtained data, the students were grouped into two groups. One group consisted of students who played the piano ($N = 63$), and the other group consisted of students who played other instruments ($N = 80$). As already stated, the reason for the large number of piano players is that the admission quotas for music schools are the highest for piano students.

variable	piano ($N = 54$) other ($N = 89$)	mean rank	Mann-Whitney U	z	p
Before the annual instrumental exam, I tremble.	piano	79.41	2053	-1.944	.048*
	other	66.16			
Before the annual instrumental exam, I feel nauseous or uncomfortable in my stomach.	piano	79.79	2029	-2.065	.039*
	other	65.86			
After the annual instrumental exam, I am calm.	piano	80.58	1979	-2.590	.010*
	other	65.24			
The annual instrumental exam gives me stress.	piano	81.01	1952	-2.405	.016*
	other	64.91			

*Note: p < .05**

Table 5: Differences in students' attitudes regarding the instrument they play obtained by the Mann-Whitney U test

As we can see from Table 5, the results indicate significant differences between piano students and other instrumentalists, as piano students reported experiencing significantly more trembling before exams ($p = .048$). They also experienced significantly more nausea or stomach discomfort before exams ($p = .039$) and felt significantly calmer than other instrumentalists ($p = .010$). Piano students agreed more strongly that the annual exam causes stress ($p = .016$). In other words, pianists exhibit stronger physical symptoms of anxiety before the exam while simultaneously experiencing greater calmness afterward and perceiving the stress more intensely. Therefore, hypothesis H3 *shows a statistically significant difference between students in their attitudes regarding the annual instrumental exam and the instrument they play*, which is also not rejected.

Finally, the obtained results were compared to verify the hypothesis H4. *There is a statistically significant difference between students' attitudes regarding the annual instrumental exam and musical tradition in the family* (Table 6).

variable	family music tradition yes ($N = 89$) no ($N = 54$)	mean rank	Mann-Whitney U	z	p
Before the annual instrumental exam, I feel my heart beating.	yes	77.29	1932	-2.017	.044*
	no	63.28			

*Note: p < .05**

Table 6: Differences in students' attitudes regarding family tradition obtained by the Mann-Whitney U-test

The analysis revealed only one significant difference out of 14 examined variables related to family music tradition. Students with a family music tradition ($N = 89$) reported significantly stronger feelings of their heart beating before the annual exam (mean rank = 77.29) compared to students without such tradition ($N = 54$, mean rank = 63.28), with this difference being statistically significant ($p = .044$). The limited number of significant differences (1/14) indicates that family music tradition has a minimal overall impact on students' exam-related attitudes and experiences, except for this specific physiological stress response. Hypothesis H4 *There is a statistically significant difference between students' attitudes regarding the annual instrumental exam and the musical tradition in the family* rejected.

DISCUSSION

The results of this study confirm previous research on the presence of strong emotional responses among students before and after the annual instrumental exam. Particularly notable are physiological symptoms such as increased heart rate, sweating, trembling, and stomach discomfort, which align with literature on music performance anxiety in children and adolescents (e.g.,

Britsch, 2005; Papageorgi, 2021). It is normal to feel anxious before exams. However, it is also important to support students so they can reduce their anxiety and feel more confident. Female students reported significantly stronger pre-exam somatic symptoms (headaches, trembling, nausea) and perceived stress, aligning with global studies on music performance anxiety (MPA) in girls (Sokoli et al., 2022; Umuzdaş et al., 2019; Baydağ and Alpagut, 2016; Patston and Osborne, 2016; Topoğlu, 2014; Thomas and Nettelbeck, 2014; Papageorgi et al., 2013; Kenny and Osborne, 2006; Rae and McCambridge, 2004). However, our work newly identifies that these differences do not extend to post-exam emotions (e.g., relief, happiness), suggesting girls may employ effective coping mechanisms post-performance – a finding not previously documented.

The findings further suggest some differences in attitudes based on grade level. Younger students' pre-exam happiness and focus on exam grades contrast with older students' post-exam calmness. This challenges prior work (Sokoli et al., 2022; Umuzdaş et al., 2019; Dempsey and Comeau, 2019; Kılıç, 2018; Shoup, 1995), implying that curricular expectations in Croatian schools may amplify grade fixation in early adolescence. The Croatian curricular context may play a role here: early-grade students may be more externally motivated and focused on outcomes, whereas older students possibly develop greater self-regulation and internal coping mechanisms through experience. These findings suggest that curricular and evaluative frameworks should be adapted across developmental stages to better support emotional well-being and learning engagement.

Interestingly, piano students reported higher stress levels than other instrumentalists despite the expectation that larger admission quotas and broader repertoires might reduce pressure. The elevated pre-exam anxiety and nausea reported by pianists support studies linking solo performance to higher stress (Sokoli et al., 2022; Umuzdaş et al., 2019; Iusca and Dafinoiu, 2012). Such findings may point to the specific nature of piano instruction and performance expectations. These results raise questions regarding how pedagogical and evaluative practices in solo instrument training might be better structured to buffer anxiety without compromising skill development or performance standards.

The effect of family musical tradition was limited. Only one significant difference was found - students from musical families reported greater heartbeat awareness before the exam, a subtle indicator of heightened physiological arousal. We assume that students from families with a musical tradition feel more pressure due to their parent's expectations of success in music, as determined by Ryan et al. (2023). Although these results may imply socially transmitted pressure to meet familial expectations, the lack of broader attitudinal differences suggests that family musical background does not significantly mitigate or amplify exam-related stress. Nevertheless, this insight can be practically relevant: educators might wish to engage in more open dialogue with musically involved families to align expectations and reduce unintended emotional burdens on students, as parental support is crucial in overcoming performance anxiety (Zarza-Alzugaray et al., 2020).

While consistent with prior research, the added value of this study lies in its focus on elementary music school students - a specific and under-researched group - and in its use of a questionnaire covering a wide range of emotional, cognitive, and attitudinal variables. Novel to our research is their paradoxical greater post-exam calmness, potentially reflecting habituation from frequent solo repertoire performances. The practical implications of these findings are multifold. First, they call for integrating structured psychological preparation programs into music curricula. Techniques such as breathing exercises, visualization, and emotional regulation training could help students navigate pre-exam anxiety more effectively. Second, the findings support the need for enhanced emotional intelligence development in music education - helping students to name, understand, and manage their emotional responses. Third, and perhaps most critically, the results question the adequacy of current evaluation systems in music schools. While performance-based assessments are integral to musical training, there is room to innovate more holistic, student-centered evaluation models that reduce psychological strain - such as incorporating formative assessments, peer feedback, and descriptive evaluations.

The study's main limitations include its reliance on student self-reporting at the time of questionnaire completion, which may introduce subjectivity and emotional bias. The lack of triangulation with teacher or parent perspectives restricts a more nuanced appreciation for student experiences. Additionally, while statistically robust, the quantitative design cannot fully capture the depth and context of students' emotional narratives. Future research should consider longitudinal methods and include teacher and parent perspectives.

CONCLUSION

This study confirmed that the annual instrumental exam provokes a wide range of emotional reactions among elementary music school students, particularly stress and somatic symptoms before the performance. Gender, grade level, and instrument type significantly influenced these attitudes, while family musical tradition had a limited impact. The findings point to the need for pedagogical measures to reduce exam-related stress, including improved psychological preparation for students, changes in the evaluation system, and additional teacher training to address students' emotional needs. Despite its limitations, this research contributes to a more profound understanding of the psychological dimensions of music education and offers a foundation for developing sensitivity and efficiency in educational policies.

We can conclude that most students experience a certain stress level during their annual instrumental exam, but afterward, they experience a sense of relief. Unfortunately, music schools employ few professional associates, including pedagogues and psychologists. Elementary and secondary music school principals emphasize the need to hire them, especially psychologists, who would provide psychological support to students before public performances during the school year and before annual exams (Sokol, 2019). We think that pedagogues and psychologists could help teachers adequately encourage and strengthen their students in stressful situations. Therefore, in our opinion, instrument teachers, in cooperation with parents, should ensure a supportive and positive atmosphere before and during the exam.

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EXPLORING HOW CHANGE LEADERSHIP INFLUENCES INSTRUCTIONAL LEADERSHIP EFFECTS ON SCHOOL CULTURE AND TEACHERS' TEACHING PERFORMANCE IN PESANTREN EDUCATION SETTINGS IN INDONESIA: A MODERATED-MEDIATION ANALYSIS

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ABSTRACT

As an instructional leader, the principal is instrumental in facilitating the adjustment to the more advanced school environment by supporting teachers and students in their endeavors. The present study investigates the moderated mediation model of how change leadership impacts instructional leadership effects on school culture and teachers' teaching performance. To this end, 459 junior high school teachers from 39 pesantren in Indonesia were surveyed, and the collected data were then examined with factor analysis and Hayes' (2013) bootstrapping technique. The results of the analysis indicate that the principal's instructional leadership has a direct and indirect effect on teachers' teaching performance through school culture. Furthermore, the findings suggest that when the professional relationship between teachers and their principals is characterized by higher change leadership, the indirect effect of the principal's instructional leadership on teachers' teaching performance through school culture is greater. This study provides evidence that principals' instructional leadership is a collaborative process as opposed to a top-down leadership model.

KEYWORDS

Instructional leadership, change leadership, school culture, teachers' teaching performance, pesantren, Indonesia

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Highlights

- *Instructional leadership directly and indirectly improves teachers' teaching performance via school culture.*
- *Change leadership strengthens the positive impact of instructional leadership on teaching performance.*
- *The study confirms school culture mediates, and change leadership moderates, the instructional leadership effects.*
- *Instructional leadership in pesantren contexts functions best as a relational, collaborative process.*

INTRODUCTION

Several studies have provided increasingly persuasive evidence to education policymakers about the ways and scope in which principal leadership contributes to teachers' teaching performance (Heck & Hallinger, 2014; Sebastian & Allensworth, 2012; Sultoni & Gunawan, 2023). Moreover, studies have demonstrated that the effect of principal leadership is particularly influential in schools facing adverse circumstances, suggesting that leadership is the most important factor for schools in challenging conditions (Duke & Salmonowicz, 2010; Wiyono et al., 2019). On the other hand, instructional leadership, a leadership model that emphasizes functions directly related

to teaching and learning (Murphy, 1988), is instrumental in achieving promising results for school performance (Marks & Printy, 2003; Sumarsono et al., 2019).

Leithwood and Louis (2011) revealed that the primary duty of a school principal is to provide instructional leadership and school management to ensure that quality of teacher instruction and educational equity are prioritized as primary goals. This is deemed essential for a school to organize, prioritize, and sustain teacher teaching and learning to create equitable learning opportunities for all students. Studies on instructionally effective schools have consistently demonstrated that principals must assume a proactive role in instructional leadership and school management (Bossert et al., 1982; Mehdinezhad & Sardarzahi, 2015). Even more, such research has suggested that this can have a profoundly positive impact on student outcomes (Devine et al., 2013; Gunawan et al., 2020).

Indeed, scholars have well-documented the challenges associated with the application of instructional leadership in education policy across various contexts in the literature examining the impact of principal leadership on teaching and learning (Nguyen et al., 2017; Pan et al., 2015; Sumintono et al., 2019). However, the construct of instructional leadership has emerged as a prominent concept in Western cultures (Hallinger & Leithwood, 1998). In many school systems, principal leadership behaviors are shaped by sociocultural norms. Therefore, principals' instructional leadership should not be taken for granted (Fromm et al., 2016). With this caveat, the current study examines the impact of principal's instructional leadership constructs on teachers' teaching performance in *pesantren* education settings in Indonesia.

The current study is particularly important in two distinct realms. First, policymakers, particularly in Indonesia and generally around the world, are becoming increasingly interested in developing reliable procedures to evaluate instructional leadership for purposes related to principal performance appraisal, leadership training programs for principals, induction programs for new principals, and evaluation of principal policy implementation. Second, this study shows that empirical research-based evidence on principals' instructional leadership can be structured for local use as well as cross-cultural and country comparisons. In essence, the current study seeks to replicate the construct of instructional leadership that originated in Western culture and be applied to *pesantren* education settings in Indonesia characterized by Islamic culture. This dual contribution offers insights to scholars and policymakers on how instructional leadership can be adopted for research and policy-oriented use in the world's diverse educational contexts.

THEORY AND HYPOTHESIS DEVELOPMENT

Instructional Leadership

Instructional leadership has been defined by Sheppard (1996) as the actions of school leaders directly related to teacher instruction, aiming to establish a learning climate and support teachers' professional learning (Hsieh et al., 2023a; S. Liu & Hallinger, 2018). In other words, the target of instructional leaders' work is the quality of instructional delivery with teachers and students at the center (Juma et al., 2021). Hallinger et al. (2015) provided a comprehensive conceptual framework to investigate instructional leadership, which incorporates three distinct dimensions: articulating a school mission and vision, managing the instructional program, and cultivating a positive learning climate.

This study uses the conceptual model of instructional leadership proposed by Bafadal et al. (2018), which consists of six dimensions: visioning of learning, visioning of an excellent school, learning culture, learning environment, promoting the school committee program for instruction, and supporting instructional success. Visioning of learning refers to the principal's behavior in formulating the vision of learning. Visioning of an excellent school refers to the principal's behavior in formulating the vision of the school's excellent program in learning. Learning culture refers to the principal's ability to create a learning-centered culture within an organization, which is achieved by changing how learning and teaching are conducted, thus stimulating a new learning atmosphere. Learning environment refers to the principal's capacity to foster an atmosphere conducive to learning by providing an environment that encourages and supports student growth. Promoting the school committee program for instruction refers to the principal's behavior of gaining school committee support for learning effectiveness. Supporting instructional success refers to the principal's efforts to assist teachers in ensuring the successful implementation of the learning plan.

Instructional Leadership and Teachers' Teaching Performance

Literature has shown that principal leadership influences teachers' classroom practices (Özdemir, 2020; Pietsch & Tulowitzki, 2017). We expect instructional leadership to positively affect teachers' teaching performance. Instructional leadership emphasizes principals' efforts to create a work environment that provides conditions for teachers to develop their teaching performance (Atalay et al., 2019). From this perspective, successful leadership is a multidimensional process centered on the leader's capacity to advance teachers' supervision, guidance, and training to provide classroom resources (Sindhvad et al., 2020).

Teacher teaching performance, defined as the ability of teachers to effectively carry out their professional duties (i.e., teaching students in the classroom), is manifested in four dimensions: lesson planning, implementing learning, evaluating teaching, and follow-up program (Kusumaningrum et al., 2019). The lesson plan is a detailed outline of the teacher's objectives and methods of instruction for a course of study, typically including specific goals, content, activities, and assessment criteria used to facilitate learning. Implementing learning is the process of interaction between teachers and students in the classroom with subject matter, delivery methods, and learning strategies. Evaluating teaching refers to assessing teaching, which involves collecting data to inform decisions that can improve the efficacy of the teaching-learning environment, ensure that the outcomes are reliable and valid, and provide guidance for future development. A follow-up program refers to an activity undertaken to follow up on a specific activity from the evaluation results.

Halverson and Clifford (2013) reported that principals who demonstrated instructional leader behaviors positively improved teachers' teaching quality. Using structural equation modeling, Bellibaş et al. (2021) reported that instructional leadership has a positive relationship with teachers' instructional practices. Their findings were empirically supported by Nurabadi, Irianto, et al. (2021), who noted a significant effect of principals' instructional leadership on teacher performance. Hence, we propose the first hypothesis as follows.

Hypothesis 1 (H1): Instructional leadership positively affects teachers' teaching performance.

School Culture as a Mediator Between Instructional Leadership and Teachers' Teaching Performance

Instructional leadership and school culture. School culture, defined as the beliefs, norms, and expectations that influence how teachers work, communicate, and behave with each other in completing instructional tasks (Sumarsono & Kusumaningrum, 2018), is manifested in five dimensions: behavioral guidelines, cultural inheritance, problem-solving guidelines, culture of responsibility, and innovation culture. Behavioral guidelines refer to a set of standards that all teachers accept to set policies at school. Cultural inheritance is an effort to store and transmit the information owned by the school through communication and teaching. Problem-solving guidelines refer to step-by-step guidelines for solving problems and making decisions. The culture of responsibility refers to the conditions under which teachers are responsible for completing tasks, working together to achieve goals, and solving problems. Innovation culture refers to teachers' creative thinking in developing new and improved services, products, and teaching processes.

We expect instructional leadership to have a positive effect on school culture. Yukl (2012) asserts leaders have a strong effect on organizational culture. Şahin's (2011b) findings on 157 urban elementary schools in Turkey showed that instructional leadership has a strong relationship with school culture. A recent study conducted by Kovačević et al. (2023) in Bosnia and Herzegovina concluded that principal leadership has a positive relationship with school culture. Thus, we propose the following second hypothesis.

Hypothesis 2 (H2): Instructional leadership positively affects school culture.

School culture and teachers' teaching performance. Teachers' teaching performance tends to improve when there is a strong impetus from a school culture where teachers believe and agree that the school aims to achieve learning (Paucar, 2014). In line with this, Engels et al. (2008) reported that school culture drives the learning and teaching process conducted by teachers in the classroom. Results obtained by Şahin (2011a) concluded that a positive school culture increases teacher collaboration and maintains teacher performance in teaching students. We thus propose the third hypothesis, which is as follows:

Hypothesis 3 (H3): School culture positively affects teachers' teaching performance.

The mediating role of school culture. Previous research has demonstrated the role of school culture as a mediator of the relationship between principals' leadership and teachers' work outcomes (Kalkan et al., 2020; Lee, 2011; Y. Liu et al., 2021). Bozkurt et al. (2021) found that school culture, promoted by leadership, served as a mediator in the relationship between leadership and teachers' collective efficacy. Burhanuddin et al. (2019) identified a mediation effect of school culture on the relationship between principals' leadership and student academic culture. This study proposes that instructional leadership predicts school culture, which in turn influences teachers' teaching performance. Thus, the following is our fourth hypothesis.

Hypothesis 4 (H4): School culture mediates the relationship between instructional leadership and teachers' teaching performance.

The Moderating Role of Change Leadership

Maintaining teachers' teaching performance in increasingly complex and evolving educational settings is an effective measure of instructional management (Andriningrum et al., 2020, 2022; Qurbani et al., 2022) because, through teaching performance, teachers get feedback on instructional quality. Change leadership, in this regard, which refers to visioning, empowering, and inspiring teachers and capitalizing on opportunities to realize smarter, faster, and more efficient instructional change (Issah, 2018), might play an important role in teachers' teaching performance.

A professional school culture allows teachers to take an attitude of inquiry, exchange knowledge, and collaborate to develop classroom materials (Schipper et al., 2020). Chen (2017) found that change leadership moderates the relationship between personality traits and motivation mechanisms. In schools with high levels of change leadership, teachers are more likely to design teaching plans, direct their instruction, and act toward achieving instructional goals in accordance with changes in the school curriculum (Nurabadi et al., 2022), thus increasing the likelihood that they will actually maintain their teaching performance. In contrast, if the principal demonstrates a low level of change leadership, teachers may be passive in responding to curriculum changes in the school, completely disengaging from the school's instructional program (Gunawan et al., 2021). Hence, the following is our fifth hypothesis.

Hypothesis 5 (H5): Change leadership moderates the relationship between school culture and teachers' teaching performance, creating a stronger relationship when the level of change leadership is higher than when it is low.

In summary, this moderated mediation model (Hayes, 2013), depicted in Figure 1, suggests that instructional leadership has a positive influence on teachers' teaching performance. This indirect connection is contingent on the degree of change leadership. Consequently, we anticipate that the connection between school culture and teachers' teaching performance will be strengthened (or weakened) when the level of change leadership is high (or low). Therefore, our final hypothesis can be stated as follows.

Hypothesis 6 (H6): Change leadership moderates the relationship between instructional leadership and teachers' teaching performance, with the mediating effect being comparatively stronger for teachers with a higher level of change leadership and comparatively weaker for those with a lower level. Specifically, this effect is mediated through the school culture.

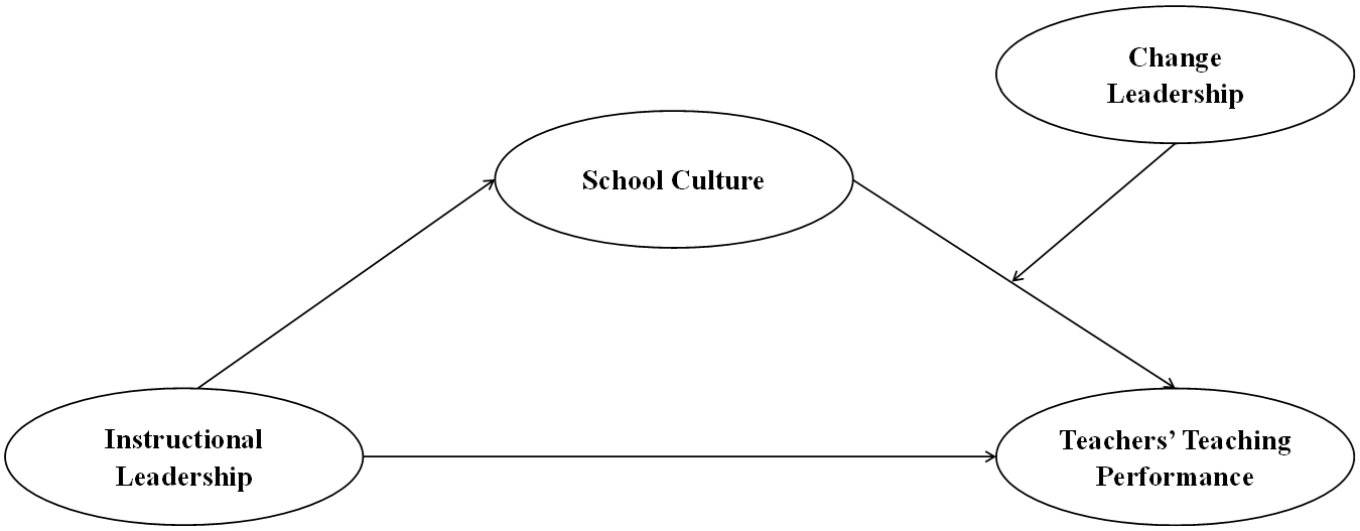


Figure 1: Conceptual research model

Context of Pesantren Education in Indonesia

Pesantren (Islamic boarding school) is a traditional Islamic education system in Indonesia whose origins can be traced back to the early 14th century with the establishment of the Pesantren Ampel Denta in Surabaya, Indonesia, in 1451 (Gunawan et al., 2021). *Pesantren* means a place for *santri* (students) to learn the Qur'an - the holy book of Islam (Ricklefs, 1993). This system has led to the provision of unique Muslim education in a largely gender-segregated setting, although as strict as it is, it depends on the flexibility of the *pesantren* leaders themselves (Srimulyani, 2007). The main purpose of *pesantren* education is to instill that learning is an obligation and a form of devotion to God, prioritize spiritual intelligence, and prepare for life after death (Assa'idi, 2021). In other words, studying in *pesantren* is not to pursue money, power, and worldly glory but to become a person who believes in God (Dhofier, 1999).

However, despite the positive contribution of *pesantren* to national education in building human resources, these educational institutions still receive discriminatory treatment in Indonesian education policy (Badrudin et al., 2017). In response, the Ministry of Religious Affairs (MRA) has recently begun to review organizational management, curriculum, professional practices of teachers, and leadership practices in *pesantren* (Kusumaningrum et al., 2018)ie calculating the mean and standard deviation. Further data is displayed in the frequency description by referring to the stanfive formula, as a reference for defining categories. The teacher empowerment rate is determined by matching the mean by the score interval of the stanfive formula. The results concluded that the level of empowerment of teachers with a mean of 77.25 included in the category is quite good. Based on the analysis of category description of each item it is known that of the 23 items there are 11 items (61.11%. In essence, the MRA has endeavored to create a network of cooperation between teachers and school principals or *pesantren* leaders to facilitate the exchange of information, experiences, and resources. It is hoped that doing so will enable the collective growth of educational and spiritual knowledge.

The policy emphasizes improving student learning outcomes through educational reforms targeting curriculum, student leadership, principals' leadership practices, and teachers' instructional practices in the classroom (Nurabadi et al., 2020). The MRA has undertaken initiatives to collaborate with universities to organize the *Pendidikan Profesi Guru* (Teacher Professional Education) program. This program aims to ensure that all teachers receive systematic training on the new curriculum and instruction methods. This program is necessary to guarantee that all teachers are adequately prepared to teach using the latest curriculum and instructional methods (MRA, 2022) and, for graduate teachers, a salary allowance.

At the same time, school principals have been subject to increased scrutiny in recent years, with a particular focus on how their leadership impacts teachers' teaching performance and students' learning outcomes (Bafadal et al., 2019). For example, professional orientation, job descriptions, induction programs for new principals, and, in recent years, instructional leadership training have been developed and implemented for school principals to equip them with the necessary skills and knowledge to effectively lead and manage their schools to make the *Merdeka Belajar* (freedom to learn) curriculum policy launched by the government in early 2020 a success (Ahmadi, 2020; Gunawan et al., 2022). The new curriculum for *pesantren* education is centered on the concept of freedom of thought for teachers and students, thus implying a greater responsibility for school principals in leading the reform. To ensure the effectiveness of this reform, collective dialogue between teachers and school principals is essential, as it allows for the recognition of the impact of culture on the teacher-principal relationship in this education system (Prasetyo, 2022). Thus, the present study is pertinent to the extant discourse surrounding *pesantren* education in Indonesia by its incorporation of school culture.

MATERIALS AND METHODS

Data Collection

A cross-sectional survey design was used in the current study. Data were collected in December 2021 from a sample of junior high school teachers in 39 *pesantren* in East Java

Province, Indonesia. With the help of the Pesantren Personnel Department, we randomly selected participants and explained the survey procedure in detail. This produced a final sample of 459 teachers. Of the 459 participants, 278 (60.57%) were female, and 181 (39.43%) were male. Our results revealed that 45.53% of participants worked for less than 10 years, 29.41% for 11-20 years, and 25.05% for more than 20 years. Educational levels were distributed at the bachelor's degree (84.75%) and master's degree (15.25%).

Survey Instruments

The questionnaire used in the survey comprised 82 items adopted from four well-developed scales based on the Indonesian context. In the questionnaire, teachers were asked to indicate their agreement to the statement by responding on a 5-point Likert scale, with 1 representing "strongly disagree" and 5 representing "strongly agree". The following describes the scales used for each research construct.

Instructional leadership. We adopted the 18-item version scale developed by Bafadal et al. (2018) to measure instructional leadership. There were 4 items on visioning of learning, such as "The principal has an understanding, is able to explain, and is able to equalize the school's vision in the field of learning"; 3 items on visioning of an excellent school, such as "The principal is able to plan the school's flagship program in the field of learning"; 3 items on learning culture, such as "Principals have the ability to demonstrate new learning models to teachers"; 2 items on learning environment, such as "The programs designed by the principal support a conducive learning climate"; 2 items on promoting the school committee program for instruction, such as "The principal involves the school committee in designing the teacher development program"; and 4 items on supporting the instructional success, such as "The principal gives full support to the learning program designed by teachers". The overall reliability coefficient was .876. The reliability coefficients for each dimension were .833, .813, .856, .857, .867, and .864, respectively.

School culture. We adopted the 12-item version scale developed by Sumarsono and Kusumaningrum (2018) to measure school culture. There were 3 items on behavioral guidelines, such as "I use the institution's objectives as a direction to carry out the institution's duties"; 2 items on cultural inheritance, such as "I believe the organizational traditions that already exist in my institution will have a positive impact on my work"; 2 items on problem-solving guidelines, such as "Every conflict that arises in the organization can always be resolved by deliberation together"; 2 items on the culture of responsibility, such as "I am responsible for every task that this institution has given"; and 3 items on innovation culture, such as "I have something new and interesting to do to support the achievement of the organization's goals". The overall reliability coefficient was .983. The reliability coefficients for each dimension were .873, .959, .940, .867, and .841, respectively.

Change leadership. This paper applied the scale developed by Nurabadi, Irianto, et al. (2021) to measure change leadership. There were 2 items on visioner, such as "Principals are able to design school programs with optimism for a bright future"; 4 items on inspiring, such as "The principal is able to inspire changes in the school to support the achievement of the school's vision"; 3 items on change strategy, such as "Every change that is launched at school is always supported by careful planning"; 3 items on applied change, such as "The change strategy set by the principal can be implemented by all school members"; and 4 items on evaluating changes, such as "Each change plan designed by the school has indicators that are used to measure the success of the planned changes". The overall reliability coefficient was .885. The reliability coefficients for each dimension were .803, .829, .817, .892, and .841, respectively.

Teachers' teaching performance. A four-dimensional scale developed by Kusumaningrum et al. (2019) measured teachers' teaching performance. There were 7 items on the lesson plan, such as "Clear formulation of learning objectives to avoid misinterpretation and ensure stated behaviors are achieved"; 20 items on implementing learning, such as "Deliver material clearly, in accordance with the learning hierarchy and student characteristics"; 2 items on evaluating teaching, such as "Conduct final assessment in accordance with competencies (instructional objectives); and 7 items on follow-up program, such as "Carry out follow-up by giving additional assignments to students as part of remediation". The overall reliability coefficient was .924. The reliability coefficients for each dimension were .837, .848, .994, and .860, respectively.

Analysis

First, we conducted a descriptive analysis and correlation matrix among the study constructs using IBM SPSS Statistics 24. Second, to check the validity of the study measures, we conducted confirmatory factor analysis (CFA) on all questionnaire items using IBM SPSS Amos Version 24. Table 2 presents model fit indicators and recommended thresholds (Hancock & Mueller, 2013). Third, to test the six hypotheses of this study, we used PROCESS Macro v4.1 (Model 4 and Model 14) developed by Hayes (2013). We tested the models using the bootstrapping technique, which includes sample size constraints by using 5000 bias-corrected bootstrap resamples to overcome possible limitations of small sample size and strengthen the confidence of inference based on sample size.

RESULTS

Descriptive Statistics and Correlation Analysis

Table 1 presents descriptive statistics and correlation analyses for four variables. As can be seen, change leadership had the highest mean (M = 4.19, SD = .42), followed by school culture (M = 4.18, SD = .34), instructional leadership (M = 4.14, SD = .40), and teachers' teaching performance (M = 4.08, SD = .40). Moreover, the correlation analysis revealed a statistically significant positive correlation between instructional leadership and school culture (R = .701, $p < .01$), change leadership (R = .787, $p < .01$), and teachers' teaching performance (R = .839, $p < .01$); school culture was significantly positive correlation with change leadership (R = .723, $p < .01$) and teachers' teaching performance (R = .731, $p < .01$); and change leadership was significantly positive correlation with teachers' teaching performance (R = .859, $p < .01$).

Variables	M	SD	1	2	3	4
1. Instructional leadership	4.14	.40	.864			
2. School culture	4.18	.34	.701**	.964		
3. Change leadership	4.19	.42	.787**	.723**	.945	
4. Teachers' teaching performance	4.08	.40	.839**	.731**	.859**	.886

*Note: N = 459; **p < .01; numbers in the diagonal rows are the square roots of the AVE*

Table 1: Means, standards deviations, and correlation

CFA Results, Convergent and Discriminant Validity

The results of CFA indicated that the measurement models had an acceptable goodness of fit (Table 2). The scale used was found to have strong convergent validity. First, the factor loadings of every construct were greater than .5. and were statistically significant ($p < .05$). Second, the composite reliability (CR) of each latent variable was found to be greater than .6 (change leadership = .644; school culture = .656; teachers' teaching performance = .687), except for instructional leadership = .599. Third, the average variance extracted (AVE) from each construct was greater than .5, indicating good reliability (Fornell & Larcker, 1981): instructional leadership = .746; change leadership = .894; school culture = .930; teachers' teaching performance = .786. Overall, these results indicated good convergent validity and discriminant validity was further verified by calculating each construct's AVE square root. Table 1 shows that the square roots of AVE were all greater than the latent variable correlation (Fornell & Larcker, 1981), supporting discriminant validity.

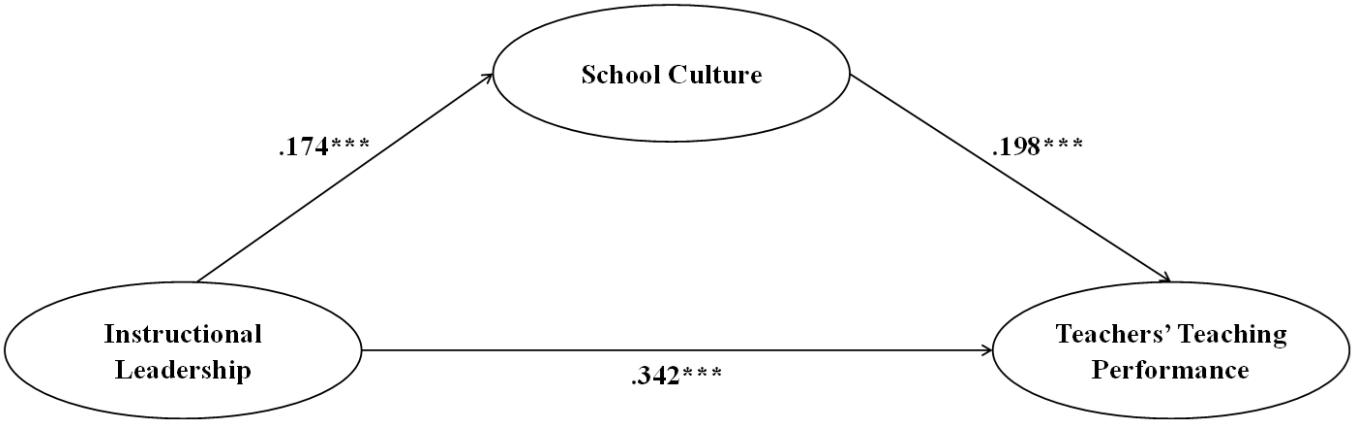
Item	Model fit criteria	Value
x^2/df	< 3.0	2.554
RMSEA	< .08	.017
RMR	< .08	.034
GFI	> .9	.978
CFI	> .9	.993
NFI	> .9	.952
TLI	> .9	.960
PNFI	> .5	.949

Table 2: Model fit of the research model

Test of Mediation

We employed Hayes' (2013) bootstrapping technique along with SPSS PROCESS v.4.1 to obtain confidence intervals (CIs) by implementing Model 4, a mediation model consisting of three linear regression equations: instructional leadership and teachers' teaching performance, instructional leadership, and school culture; and instructional leadership, school culture, and teachers' teaching performance. As Table 3 shows, instructional leadership could positively predict teachers' teaching performance ($\beta = .308$, SE = .060, $t = 5.167$, $p < .001$) and school culture ($\beta = .174$, SE = .053, $t = 3.289$, $p < .001$), and school culture could positively predict teachers' teaching performance ($\beta = .198$, SE = .068, $t = 2.872$, $p < .001$). Thus, we confirmed H1, H2, and H3.

The bootstrap 95% confidence interval (CI) for the effect of instructional leadership on teachers' teaching performance and school culture, as indicated by Table 4, did not span zero ($\beta = .342$, SE = .060, 95% CI = [.227, .459], excluding 0, $p < .001$), indicating that instructional leadership indirectly predicted teachers' teaching performance through school culture (see Figure 2). The direct and mediation effects analysis revealed that 90.06% and 9.94% of the total effects were accounted for, respectively. These results support H4.



*Note: *** p < .001*

Figure 2: The relationship between instructional leadership and teachers' teaching performance through school culture

Outcome Variables	Independent Variables	*B*	SE	*t*	Bootstrap LLCI	Bootstrap ULCI
Teachers' teaching performance	Instructional leadership	.308***	.060	5.167	.190	.425
School culture	Instructional leadership	.174***	.053	3.289	.070	.278
Teachers' teaching performance	Instructional leadership	.342***	.060	5.783	.227	.459
	School culture	.198***	.068	2.872	.062	.333

*Note: *** p < .001*

Table 3: Mediation model test for school culture

	Effect	SE	Bootstrap LLCI	Bootstrap ULCI	Relative Effect Size
Total effects	.342	.059	.226	.458	
Direct effects	.308	.060	.190	.425	90.06%
Mediation effects of school culture	.034	.017	.006	.073	9.94%

Note: Bootstrapping was set at 5000 samples

Table 4: Total, direct, and mediation effects of school culture

Test of Moderated Mediation

As Table 5 shows, moderated mediation analysis using Hayes (2013) SPSS PROCESS v.4.1 by employing Model 14 on the moderating effect of change leadership found a significant moderated mediation index (b_{modmed} = .050, SE = .035, 95% CI = [.003, .130], excluding 0). Therefore, the results confirm that the indirect effect of instructional leadership on teachers' teaching performance through school culture was moderated by the level of change leadership, providing support for H5.

This study divided change leadership into three groups (high, medium, and low) based on their mean and standard deviation. Under different levels of change leadership, the mediating effect of school culture between instructional leadership and teachers' teaching performance is compared (Table 6). Under instructional leadership, the mediating effect with a high level of change leadership (95% CI = [.010, .099], excluding 0), a medium level of change leadership (95% CI = [.001, .063], excluding 0), and a low level of change leadership (95% CI = [.036, .047], excluding 0), is significant. Therefore, H6 is verified. Our results demonstrated a moderating effect of change leadership (Figure 3), whereby an increase in change leadership strengthened the positive influence of school culture on teachers' teaching performance.

Mod	Med	Index	SE	Bootstrap LLCI	Bootstrap ULCI
Change leadership	School culture	.050	.035	.003	.130

Note: Bootstrapping was set at 5000 samples, Mod = Moderator, Med = Mediator

Table 5: Index of moderated mediation

Groups		Moderated mediation effect	SE	Bootstrap LLCI	Bootstrap ULCI
Instructional leadership	Change leadership - high level	.047	.023	.010	.099
	Change leadership - medium level	.027	.016	.001	.063
	Change leadership - low level	.006	.020	.036	.047

Note: Bootstrapping was set at 5000 samples

Table 6: Conditional indirect effect at values of the moderator

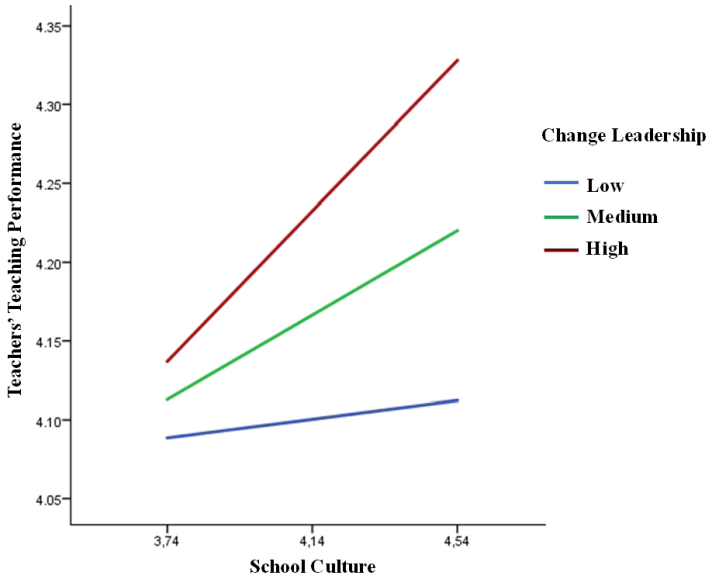


Figure 3: Moderating effect of change leadership

DISCUSSION AND CONCLUSION

This study examines the moderated-mediated effect of leadership on teachers' teaching performance. It investigated the role of school culture as a mediator and change leadership as a moderator in mediating the effect of instructional leadership on teachers' teaching performance. In this section, we highlight the meaning of the findings. The findings are discussed regarding their implications for research, policy, and practice. Additionally, the limitations of the study are highlighted.

Interpretation of the Findings

The current study found direct and indirect effects of instructional leadership on teachers' teaching performance. The direct effect of instructional leadership accounts for a much higher proportion (90.06%) than the indirect effect (9.94%) on teachers' teaching performance. This finding echoes the work of Bellibaş et al. (2021), who found that instructional leadership supports teachers' instructional practices. This indicates that instructional leadership could influence teachers' teaching quality and support teaching effectiveness, e.g., school resource allocation, teacher coaching, and protecting instructional time (Al-Mahdy et al., 2022; Hsieh et al., 2023b).

At the same time, the mediation model employed in this study validated significant indirect effects, thereby demonstrating the importance of principals creating beliefs, norms, and expectations to motivate teachers to facilitate improved instructional practices. Moreover, this study focused on school culture. Yet, other research has underscored the significance of other teacher attitudes and values in the process of enhancing instruction, e.g., commitment (Hosseingholizadeh et al., 2020), trust (Karacabey et al., 2022), voice behaviors (Hsieh et al., 2024) and collective efficacy (Bozkurt et al., 2021) as possible constructs through which leadership positively impacts teachers' instructional practices.

The current study's findings become more meaningful when interpreted in the context of previous research that has extended the mediation model to incorporate student learning outcomes. This is evidenced in the four findings reported in the works of Dutta and Sahney (2022), Leithwood et al. (2020), Y. Liu et al. (2022), and Sebastian and Allensworth (2012). First, the four studies reported that principal leadership focused on enhancing teachers' classroom instruction had a notable impact on both instructional quality and student learning outcomes. Second, studies by Leithwood et al. (2020), Dutta and Sahney (2022), Y. Liu et al. (2022), and Sebastian et al. (2016) have highlighted the importance of emotion, school climate, self-efficacy, and professional community as mediators of the impact of principal leadership on teachers' instructional practices. Moreover, the study of Leithwood et al. (2020), which examined a four-path model of leadership effects on student learning outcomes (i.e., rational, emotional, organizational, and family), further confirmed that the rational pathway (i.e., teachers' classroom instruction) has the most prominent direct effect.

This study contributes to the literature on change leadership and instructional leadership by demonstrating teachers' perceived influence of change leadership on the professional relationship with the principal in an Indonesian *pesantren* context. Two main findings emerged from our study. First, we found that change leadership has a small but statistically significant influence on instructional leadership displayed by *pesantren* principals in Indonesia (β = .050), thereby substantiating the relevance of change leadership in this context to support the implementation of instructional leadership (Bafadal et al., 2019). Furthermore, our results suggest that when teachers perceive higher levels of change leadership in their professional relationships with their principals, the indirect effect of instructional leadership on teachers' teaching performance through school culture is stronger. This result is consistent with the findings of Thoonen et al. (2011) in the Netherlands, where professional learning activities were the dependent variable. Our results indicate that stronger instructional leadership effects are associated with closer professional relationships between teachers and their principals in contexts characterized by high levels of change leadership.

Second, although the *pesantren* education setting in Indonesia has a hierarchical social culture, the perceived change leadership of the principal perceived by teachers is in the high category (M = 4.19). This is quite similar to the findings of Mangulabnan et al. (2021) in the Philippines (M = 4.24). This finding is interesting as both countries try to rise by designing school reforms and promoting continuous teacher instruction (Maisyaroh et al., 2021). This could indicate that both countries' norms are changing due to the globalization of education.

Finally, the current study has drawn the following conclusions: First, principals should prioritize improving teachers' instructional quality in the classroom when attempting to promote student learning. Second, principals need to cultivate teachers' positive attitudes, such as commitment, trust, and collective efficacy, to support them in developing their instructional skills and teaching more effectively. Furthermore, this result underlines that instructional leadership by principals is a relational process.

Implications for Research and Practice

The findings of this study have implications for research. First, this study supports the necessity to further explore the relationship between instructional leadership and teacher teaching performance through quantitative and qualitative research. A notable irony is that, in the focus on student achievement, the importance of the mediating pathway factor of teacher teaching performance, which is subject to the effects of principal leadership, may have been overlooked (Leithwood et al., 2020). Future studies on different national contexts could be enriched and expanded by elucidating the leadership pathway.

Second, we postulate that a research design that places teacher psychological empowerment as a mediator of leadership on teacher teaching performance is of great importance, as it is through teacher teaching performance that schools can most effectively foster and enhance teachers' instructional capabilities. To further refine this research design, we suggest that studies include teacher attitudes (e.g., efficacy, commitment, agency, trust) as mediators. Additionally, contrasting approaches from previous studies could be incorporated to construct new studies and inform the design of future studies (Özdemir, 2020; Thoonen et al., 2011).

Third, this study promotes research on principals' application of instructional leadership in different national contexts, offering

insights into how institutional culture influences behavior (i.e., leadership). This construct requires a collection of findings from different cultural contexts for generalization of results and more trust. This is an important requirement in building a global knowledge base. Various aspects of the current study can be explicitly linked to previous studies conducted, e.g., in China (Zheng et al., 2019), Singapore (Ng et al., 2015), Taiwan (Hsieh et al., 2023b), Japan (Kim & Lee, 2020), Turkey (Karacabey et al., 2022), Oman (Al-Mahdy et al., 2022), United States (Burch, 2007), Chile (Leiva et al., 2017), Kenya (Juma et al., 2021), South Africa (Bush, 2013), Greece (Kaparou, 2015), and Netherlands (Thoonen et al., 2011).

Fourth, this study contributes to the field by providing evidence of the value of using a moderated mediation design to investigate the effects of principal leadership. By adding moderation analysis to the already accepted mediation model, our research offers a comprehensive conceptual and analytical framework for exploring the relationships between principal leadership and teacher instruction.

Finally, our research has implications for education policymakers and practitioners in Indonesia and other communities exploring ways to enhance principal instructional leadership in school settings. Our findings suggest that success in this endeavor requires support for teachers' instructional practices in the classroom, achieved through support, coaching, and access to ongoing professional development opportunities. Specifically, we observed that teachers and principals were recently trained in the *Merdeka Belajar* curriculum series; however, to ensure that this training leads to effective instructional practices, school leaders must continue providing support and coaching to teachers. Furthermore, to ensure these practices are sustained, school leaders must ensure teachers have access to ongoing professional development opportunities. Ultimately, this research supports the need for school leaders to provide instructional leadership to promote effectiveness. Moreover, the induction program for new principals based on mentoring (Nurabadi et al., 2020; Nurabadi, Suhariadi, et al., 2021) should be an entry point for the ministry to promote instructional leadership.

For practitioners, the current study's findings suggest that instructional leadership, when used to strengthen the principal-teacher professional relationship, has a strong positive effect on learning. This is further supported by the moderating effect of change leadership and the mediating effect of school culture. These results are consistent with earlier research, which indicated that principal leadership has a significant impact on various teacher attitudes, such as efficacy (Zheng et al., 2019), commitment (Hosseingholizadeh et al., 2020), trust (Karacabey et al., 2022), and agency (Al-Mahdy et al., 2022). Finally, this research reinforces the notion that instructional leadership can be viewed as a form of relational leadership in which principals are responsible for cultivating a culture of trust and high standards in their schools. Rather than a hierarchical approach to school administration, this form of curriculum and teaching management involves a collaborative effort between principals and teachers, thereby strengthening their professional relationships.

Limitations and Future Research Directions

This study has several limitations that should be taken into consideration. First, the cross-sectional research design of this study hinders its ability to establish a causal relationship among the variables. As such, the results of this study should be interpreted as merely reflecting the correlations between the constructs investigated. To overcome this limitation, future research should employ a longitudinal research design. Second, this study only evaluated teachers' perceptions of instructional leadership from principals. Thus, future research should expand this investigation's scope by assessing instructional leadership from other sources, such as department heads, teacher leaders, vice principals, or supervisors. Third, the study sample was only teachers from *Pesantren* at the junior high school level, meaning that our findings may not represent the entire population of *Pesantren* teachers in Indonesia. It is suggested that further studies would be better to use a random sampling strategy to select *pesantren* teachers from different levels across Indonesia to ensure the validity of the findings.

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Full research paper

TOO MUCH OF EVERYTHING IS BAD: THE CASE OF CZECH UNIVERSITY STUDENTS' WORK-STUDY BALANCE DURING THE COVID-19 PANDEMIC

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ABSTRACT

Students are an exceptionally vulnerable population in comparison to any other age group. Many students face considerable stress stemming from the combined demands of their studies and, for some, the necessity to work. This situation presents a serious dilemma of how to combine work and study, how to maintain mental well-being. We explored the work-study balance by analyzing a repeated cross-sectional sample of 8,584 Czech university students at two time points (2020 and 2021) during the pandemic outbreak. Employment benefits students' mental health, but students who worked extra hours had more depressive symptoms than those who worked part-time or full-time. In addition, an increasing study load had a negative effect on students in the form of increased depressive symptoms. Both students who were employed before the pandemic but were no longer working during it and students who never had a job had significantly higher depressive symptoms than working students. The expectation of a detrimental high workload-high study load effect was not confirmed.

KEYWORDS

Covid-19, CES-D 8, role enrichment, role overload, study, university students, work

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Highlights

- *The Czech Republic has one of the highest numbers of working students, yet research on the effect of combining work and study is lacking to date.*
- *This article uses unique Czech data, with over 9,000 Czech students participating in two data collections.*
- *Employment benefited the students' mental health during the Covid-19 pandemic.*
- *High study load had a negative impact on students' mental health during the Covid-19 pandemic.*

INTRODUCTION

University students are vulnerable in terms of mental health: many suffer from several depressive symptoms (Mikolajczyk et al., 2008; Rückert, 2015), which have gradually become more pronounced for about a decade (Lipson et al., 2022). Moreover, university students have a higher prevalence of mental health problems in comparison to the general population (Dahlin et al., 2005; Kumar, 2016; Kurre et al., 2011; Verger et al., 2010). This may be because transitioning from school to the university level raises many personal and academic challenges (Rickinson, 1998). These emerging adults are in a unique phase of life when they are still dependent on their parents to some extent but are slowly becoming more detached, leaving adolescence behind but not yet reaching full adulthood (Arnett, 2007). As the cost of university and everyday living rises, students must ensure they can make ends meet. Some Czech students are supported by their parents or partners. However, they still have to work long hours to finance their education, which might hurt their academic achievement and overall education (Fischer and Vltavská, 2016). Two-thirds of students report they could not study without working simultaneously (King and Bannon, 2002). Research shows that 92% of Czech students in 2019 had a paid job, and 74% combined work and study during their courses, making the Czech Republic a country with one of the highest numbers of working students (Hauschildt et al., 2019). Almost two-thirds of the students working more than 20 hours a week claim they work to be able to cover their living costs, and 29% declare strong agreement with the statement they need to work to afford to study. And yet, despite their work efforts and also given the urgency of their reasons for needing to work, students' earnings are below average in comparison to other countries participating in the EUROSTUDENT survey (Hauschildt et al., 2021).

The Covid-19 outbreak has led to many sudden changes in, among other things, the field of university studies, work, and organization. While there is no systematic evidence of job losses and a deteriorating material situation for university students, the assumption is that the already dire situation of working students before the pandemic has only intensified. The pre-pandemic literature shows that changes in the labor market disproportionately affect younger people, who are often in precarious positions due to having only temporary employment contracts and are, therefore, more vulnerable to job loss than older age groups (MacDonald and Giazitzoglu, 2019). Some early pandemic studies already noted significant concerns about job loss (Birmingham et al., 2021; Nunn et al., 2021). This is disturbing since job loss correlates with increased depressive (Paul and Moser, 2009; Rosenthal et al., 2012) and anxiety levels (Paul and Moser, 2009) and a decrease in overall well-being (Flint et al., 2013; Paul and Moser, 2009). Moreover, the negative effects of employment loss are amplified when the unemployed cannot spend time in meaningful activities, including spending time with other people (Winefield et al., 1992), which was hindered during lockdowns. Higher education suddenly went online. Teachers, as well as students, had to adapt to the pandemic by switching to the online mode of study. While the results of comparing face-to-face and online learning from the pre-pandemic period are ambiguous, some suggest there are no differences (Fortune et al., 2011), while others show higher satisfaction among those taking face-to-face courses (Tratnik et al., 2019). These studies are small-scale and influenced by the context. In that period, students had the privilege of choosing between the study modes based on their needs, but in the pandemic, the online mode was unavoidable. That is also likely why more recent pandemic evidence suggests a strong preference for face-to-face learning over online learning, despite the obvious positives of online study, such as greater time efficiency (Kanojiya, 2020; Lemay et al., 2021). Students also emphasized the disadvantages of the online mode, such as social distancing and social isolation (Kanojiya, 2020; Lemay et al., 2021). Moreover, students' workload for university has significantly increased, or at least they perceive it to have done so (Lemay et al., 2021), likely adding to already elevated mental distress.

According to evidence, handling the commitments of paid work and study can be a source of stress (Jogaratnam and Buchanan, 2004), but so are insufficient financial funds (Monk, 2004; Stanley and Manthorpe, 2002). Long working hours, in particular, can cause work overload and be detrimental to mental health (Ogawa et al., 2018; Wong et al., 2019). However, learning new soft and hard skills at work can benefit students and enrich their role and, subsequently, their well-being (Curtis and Shani, 2002; Nicklin et al., 2019). Moreover, during the Covid-19 pandemic, working undergraduates had better psychological health than non-working students (Barros et al., 2022).

Understanding the relationship between working and studying is crucial as it directly affects the academic success, financial stability, and overall well-being of students who are already at high risk of depressive. This relationship is increasingly important as more students work part-time or even full-time while pursuing their education. Notably, the study and work balance among university students is understudied. The vast majority of the very few studies conducted on a similar topic are small scale analyzing only lower hundreds of students' responses (Barros et al., 2022; Butler, 2007; Curtis and Shani, 2002; Nicklin et al., 2019) and they tend to focus on academic performance (Butler, 2007; Curtis and Shani, 2002; Elling and Elling, 2000; Volkwein, 1989), or they consider only full-time workers (Butler, 2007), not taking into account the impact of job loss**.** In our manuscript, we focus on how work and study are interlinked to bridge all the mentioned empirical gaps: whether they complement each other, benefiting students' mental health or deleterious to students' well-being.

THEORETICAL BACKGROUND: COMBINING WORK AND STUDY

Role Overload

Previous research focusing on working university students usually presumes a conflict of roles induced by role strain and the difficulty of meeting multiple obligations placed on students by the very definition of emerging adulthood (Cook, 2015). According to the studies, devoting limited time and energy to work depletes resources meant for fulfilling school responsibilities and the other way around (Hall, 1972). Empirical evidence shows that long working hours predict poorer academic performance (Derous and Ryan, 2008; Miller et al., 2008; Salamonson and Andrew, 2006; Trockel et al., 2000), overall increased work-school conflict (Butler, 2007) and subsequently also reduced psychological well-being (Salamonson and Andrew, 2006; Trockel et al., 2000). All this may result in poorer study skills (Lammers et al., 2001) and role overload (Hecht, 2001). Academic and extracurricular activities, financial burdens, and separation from family lead to work stress and role overload (Agrawal and Chahar, 2007). Role overload prevalence is high in the college population (Cook, 2015).

Role Enrichment/Enhancement

In contrast to the literature pointing out the conflicts in roles and overwork in one or the other domain, some studies did not reveal a negative correlation between work hours and academic performance (Elling and Elling, 2000; Volkwein, 1989). And when the roles are not draining but fulfilling and complement one another, they might enhance each other (Marks and MacDermid, 1996; Sieber, 1974). This principle, known as enrichment theory, assumes a positive implication (Blom et al., 2007; Carlson et al., 2006; Greenhaus and Powell, 2006). There is strong evidence supporting the idea of work and school enrichment (Butler, 2007; Greenhaus and Powell, 2006), emphasizing that students might learn new skills or enhance existing ones (Lucas and Lammont, 1998; Pickering et al., 2000), experience enhanced esteem and also benefit from gaining an income at work that can subsequently improve their performance at school or provide them with better conditions for learning. Thus, there is an assumption that greater time investment in both study and work potentially benefits mental well-being.

Conflicting or Complementing Concept?

While economic reasons drive students to seek work, work also provides an emotional experience that can benefit overall social development (Lucas and Lammont, 1998) and increase

opportunities for advancement and marketability for future jobs (Hornung et al., 2008). Even though they are often considered separate and conflicting spheres, there is evidence to suggest overlap to the extent that they enhance and complement each other, helping students acquire soft and hard skills depending on the nature of their studies and work (Miller et al., 2011). This multiple-role involvement that may lead to a meaningful sense of self can, in turn, also enhance well-being (Creed et al., 2015; Thoits, 1986). It is, however, likely that role enrichment is only applicable to some extent. The enrichment effect might be negated if the students experience excessive stress and are overloaded at work or in their studies. This would produce strain and stress, leading to role overload and subsequently also to the deterioration of their well-being (Buda and Lenaghan, 2005). There is, however, also isolated evidence to suggest that, under certain circumstances, combining work and school is double-edged, both deteriorating and enriching (Butler, 2007).

Hypotheses

Based on previous empirical and theoretical evidence, we formulate the following hypotheses:

H1: University students working part-time and full-time will exhibit fewer depressive symptoms than non-working students.

H2: University students working excessive hours (more than 40 per week) will manifest more depressive symptoms than students working part-time or full-time.

H3: Too many hours spent studying will be detrimental to university students' mental well-being. The more hours students spend in face-to-face lectures, online classes, and self-study combined, the greater their depressive symptoms.

H4: Students who were employed before the pandemic but were no longer working during it will have a higher depressive score than students working part-time and full-time.

H5: Working students with high levels of study will have more depressive symptoms than non-working students with high levels of study.

Data Measurement and Methods

This article concludes with repeated cross-sectional data mapping of the well-being of Czech university students in the years 2020 and 2021. The first dataset was collected as a part of the Covid-19 International Student Well-being Study (C19 ISWS) at the very beginning of the Covid-19 pandemic (Van de Velde et al., 2021). We collected 6,497 answers from Czech students from April 29 to May 19, 2020. It was a time when little was known about the Covid-19 pandemic. The number of cases in the Czech Republic was low, and the number of people who recovered was higher than the number of active cases. Moreover, the restrictions were easing up at that time. The other data collection was realized at the end of the third wave of Covid-19 in the Czech Republic; we collected 5,595 answers between May 18 and June 30, 2021. This was also a time of gradual loosening of pandemic measures and schools reopening. However, the university facilities were the last to be opened, and this opening coincided with the exam period of most universities. Both surveys were conducted online by the Faculty of Social Sciences of Charles University and the Institute of Sociology of the Czech Academy of Sciences. In both years (2020 and 2021), universities were contacted by email and telephone to ask if they would be willing to send information about the survey to their students with a link to complete the survey. Once they expressed willingness, their management distributed an email within the university containing a link to the questionnaire, which students accessed and completed independently. Both surveys were considered and approved by the Research Ethics Committee of the Faculty of Social Sciences at Charles University.

Sample

The analytical sample consists of 8,575 Czech-speaking university students between 20 and 34 years of age (4,975 respondents in 2020 and 3,600 respondents in 2021). Our data version does not contain respondents outside the "standard university student age" and English-speaking respondents. We implemented the listwise deletion method (case is dropped from the analysis because of a missing value in at least one of the specified variables). The biggest loss of cases is due to missing values in the variable measuring the study load (678 missing values in 2020 and 350 in 2021). On the other hand, there were very few missing values in the variables measuring age, gender, study program, and academic field.

Measurements

The dependent variable, perceived and self-reported **depressive symptomatology**, was measured using the 8-item Center for Epidemiologic Studies Depressive Scale (CES-D 8). Respondents were asked to indicate how much of the time during the past week they: a) felt depressed, b) felt that everything they did was an effort, c) sleep was restless, d) were happy, e) felt lonely, f) enjoyed life, g) felt sad, h) could not get going. The responses were divided into four categories: (1) none or almost none of the time, (2) some of the time, (3) most of the time, (4) all or almost all of the time. The resulting sum score ranged from a low of 8 (low depressive symptomatology) to a high of 32 (high depressive symptomatology). CES-D8 is widely used for measuring symptoms of depressive (Huijts et al., 2013; Von Dem Knesebeck et al., 2011; Missinne and Bracke, 2012) and has been validated (Karim et al., 2015; Klusáček et al., 2022; Van de Velde et al., 2009). The distribution by collection year is shown in Figure 1. While the shape of the histogram is similar in both years of data collection, there is a distinct shift toward higher depressive among students in the spring of 2021.

The independent variables were the **study** and **paid workload**. We measured the study load as the amount of time per week dedicated to online, personal, and face-to-face study combined. The workload was measured by a single question on the amount of time per week dedicated to paid work. Workload measured in hours is widely used in studies testing the effect of high work or study burden on mental health in the general population (Choi et al., 2021; Masui et al., 2014; Toubasi et al., 2023; Weston et al., 2019; Yao and Chen, 2023; Yoon et al., 2018). The main advantage of this approach is comparability between students. Still, this comparability comes at the cost of not capturing the complexity of the study and paid workload (intensity, difficulty, and emotional demands of the tasks).

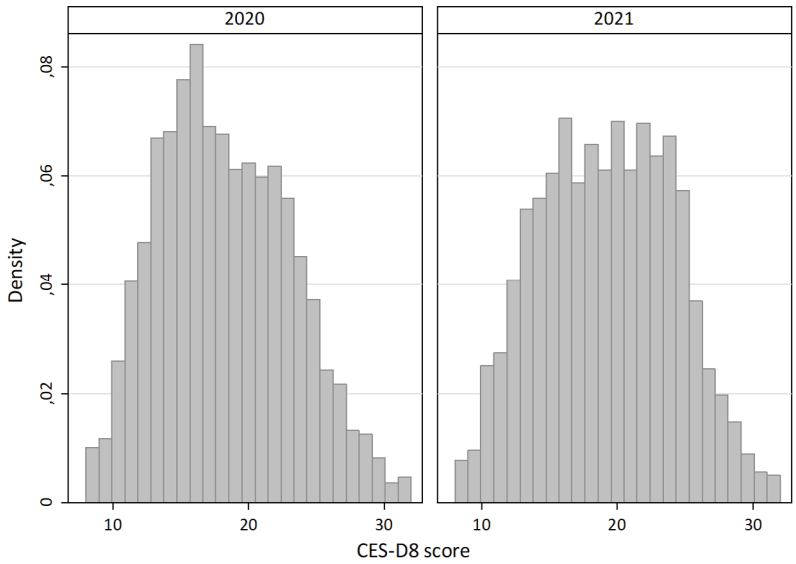

Figure 1: Histogram of CES-D8 by year collection. *N*(2020) = 4,975; *N*(2021) = 3,600

These two variables were recoded into the following categories: 0 hours, 1-10 hours, 11-25 hours, 26-40 hours, and more than 40 hours. To test Hypothesis 4, we further divided the "0 hours" work category into "No job before Covid" (students who declared zero hours worked before the pandemic and during the pandemic as well) and "No longer working during Covid" students who worked at least some hours before the pandemic but declared zero hours worked during the pandemic. To test Hypothesis 5, we further collapsed the paid workload variable into three categories: no paid work (0 hours), part-time work and full-time work (1-40 hours), and overtime working hours (more than 40 hours). Studies on testing the effect of high work or study burden on mental health usually use categorized work or study hours variables (Choi et al., 2021; Weston et al., 2019; Yoon et al., 2018).

Table 1 shows descriptive statistics for independent variables by year of collection. Very few students reported zero hours of study load, while a share of students with paid jobs stood at 58% in 2020. A year later, the percentage of students who reported no workload at all dropped to about 43%. Online study, which included lectures and seminars delivered through the Internet, was not so prevalent in 2020, but the hours spent on online learning increased in 2021. A similar trend appears for face-to-face lectures and seminars, which were not widely prevalent in 2020 due to lockdowns. Therefore, these limited universities' ability to function as they gradually adapted to the new situation. However, in 2021, face-to-face lectures were slightly more frequent, especially in applied study fields that require internship experience.

Workload	2020		2021	
(hours)	*N*	%	*N*	%
No job before covid (0)	1,385	27.8	1,007	28.0
No longer working during covid (0)	1,507	30.3	550	15.3
1–10	681	13.7	702	19.5
11–25	750	15.1	770	21.4
26–40	520	10.5	432	12.0
>40	132	2.7	139	3.9
Total	4,975	100.0	3,600	100.0
Study load	**2020**		**2021**	
(hours)	*N*	%	*N*	%
0	134	2.7	207	5.8
1–10	1,224	24.6	557	15.4
11–25	1,879	37.8	1,162	32.3
26–40	1,027	20.6	885	24.6
>40	711	14.3	789	22.0
Total	4,975	100.0	3,600	100.0

Table 1: Descriptive statistics for independent variables by year of collection

The analyses include several control variables to account for factors that may influence students' mental health outcomes. **Age** (continuous, 20–34 years) and **gender** (male, female) were included as key demographic factors, as previous research has shown that younger adults (Velten et al., 2018) and women are generally more vulnerable to mental health issues, particularly

during periods of heightened stress (Kartalova-O'Doherty and Tedstone Doherty, 2010). **Study programs** (bachelor, master, doctoral) and **academic fields** (professions and applied sciences, humanities, social sciences, natural sciences, IT, medicine) were controlled for, as different levels of study and disciplines vary in terms of academic pressure, workload, and career expectations, creating an academic stress pressure all of which can impact stress and mental well-being (Deng et al., 2022). We also included **having a confidence**, measured by whether the respondent has someone to discuss personal matters with. Social support is a well-established protective factor against psychological distress, buffering against stress and mitigating depressive symptoms (Li et al., 2023). Women were predominant in our analytical sample (74% in 2020 and 68% in 2021). In both years, most students consisted of bachelor students (approximately 59% in 2020 and 52% in 2021). The representation of individual fields of study is similar for 2020 and 2021, except for medical students, whose numbers were 10% higher in 2021. The percentage of respondents with no confidence was around 7% in 2020 and 9% in 2021.

	2020		2021	
	N	%	*N*	%
Gender				
Male	1,310	26.3	1,162	32.3
Female	3,665	73.7	2,438	67.7
Degree				
Bachelor	2,915	58.6	1,858	51.6
Master	1,855	37.3	1,524	42.4
PhD	205	4.1	218	6.0
Academic field				
Professions	2,100	42.2	1,343	37.3
Humanities	719	14.5	468	13.0
Soc. Sci.	490	9.9	335	9.3
Nat. Sci.	980	19.7	628	17.4
IT	372	7.5	234	6.5
Medicine	314	6.3	592	16.5
Confidant				
Has a confidant	4,615	92.8	3,289	91.4
No confidant	360	7.2	311	8.6
	M	SD	*M*	SD
Age	22.8	2.5	23.6	2.9

Table 2: Descriptive statistics for control variables by year of collection

Analytical Procedures

We used linear multiple regression to examine the relationship between workload, study, and depressive symptoms. Multicollinearity was assessed using variance inflation factors (VIF), and all VIF values were below the commonly accepted threshold of 10, indicating no serious multicollinearity problems (see Appendix A). The Breusch-Pagan test was utilized to determine if heteroskedasticity is present. The results indicated that heteroskedasticity is not present (the p-value of Chi-Square test statistics is more than.05). This means that we can assume that the error terms have constant variance.

We also graphically inspected residual values. This way, we can identify issues such as heteroscedasticity, nonlinearity, outliers, or systematic patterns in data. None of the diagnostic plots suggested that such an issue occurred. One of the diagnostic plots (the histogram of the residuals) is in the supplemental materials (see Appendix B). All analyses were conducted using STATA, and results were checked for consistency through sensitivity checks, including alternative model specifications and the inclusion/exclusion of control variables.

RESULTS

Work and study load among students and their effect on mental health in students

Table 3 presents results from multiple linear regression with depressive symptoms as the dependent variable. The models were structured to systematically examine the effects of workload and study load while accounting for potential differences across the two data collection periods. Model 1 includes workload and study load without interactions with the year of data collection. This baseline model establishes their overall associations with depressive symptoms, independent of temporal variation. Model 2 introduces an interaction between workload and the year of data collection to assess whether the impact of workload on depressive symptoms differs between the two-time points. Model 3 similarly tests the interaction between study load and the year of data collection, allowing us to evaluate whether study load effects differ between 2020 and 2021. The regression models with more details (such as confidence intervals) can be found in Appendix C.

The trends are different for workload and study load. We used a moderate workload (11-25 hours) as a reference category.

The findings suggest that there are notable differences between working students who have a weekly workload between 1-10 hours ($\beta = 0.264$; not statistically significant), 11-25 hours, and 26-40 hours ($\beta = 0.017$; not statistically significant) per week, and non-working students ($\beta = 0.611;\ p < .001$). Working students tend to have a lower number of depressive symptoms than those who report no working hours. There was a positive and significant effect of students working excessive hours ($\beta = 1.021; p < .01$). We also visualized the relationship between work and depressive symptoms using predicted values according to hours of paid workload from multiple linear regression (Figure 2). The relationship between variables has a notable U-shape in both surveyed years (2020 and 2021). Clearly, it shows that students with no working hours or students working overtime suffer from more depressive symptoms than students working part-time and full-time.

As for the study load, the students who claimed to have a moderate study load (11-25 hours) were used as a reference category. The overall resulting coefficients suggest that the more hours of study university students had, the worse their mental state. There seems to be a breaking point between categories 26-40 and >40. Students who reported not having to study ($\beta = -0.540$; not statistically significant) or that their study took only a negligible amount of time during the week ($\beta = -0.371;\ p < .05$) had a lower depressive score in comparison to the reference category, students devoting 26-40 hours to their study ($\beta = 0.553;\ p < .001$) and students studying more than 40 hours per week ($\beta = 1.844;\ p < .001$) had a higher depressive score in comparison to the reference category. Figure 2 portrays the relationship between study and depressive symptoms in time: in 2021, the relationship is linear, while in 2020, a generally upward trend is observed with some variation in the lowest study load category. This inconsistency is because very few students had a zero-study load in 2020.

As for the control variables, there is a notable effect of gender: women tend to suffer from significantly more depressive symptoms than men ($\beta = 0.610$; $p < .01$). Students in Humanities, in particular, exhibit higher depressive than profession-oriented students ($\beta = 0.979$; $p < .001$). Also, the most mentally overwhelmed students were PhD candidates ($\beta = -1.228$; $p < .001$). Respondents with a confidant had a much lower depressive score ($\beta = -4{,}120$; $p < .001$). The differences in depressive symptoms scores between 2020 and 2021 are especially notable in Figure 2, and the coefficient has significant effect sizes indicating more serious mental health results in 2021 ($\beta = 0.896;\ p < .001$).

	(1)	(2)	(3)
	CES-D8	CES-D8	CES-D8
Female (ref. male)	0.610***	0.616***	0.608**
Age	0.002	0.003	-0.001
Academic field (ref. Professions)			
Humanities	0.979***	0.983***	0.975***
Soc. Sci.	0.236	0.240	0.239
Nat. Sci.	0.168	0.166	0.152
IT	0.267	0.249	0.269
Medicine	-0.021	-0.039	-0.033
Degree (ref. Bachelor)			
Master	-0.473***	-0.480***	-0.476***
PhD	-1.228***	-1.233***	-1.234***
Has a confidant (ref. No confidant)	-4.120***	-4.118***	-4.119
Study load (ref. 11-25)			
0	-0.540	-0.556+	0.307
1-10	-0.371*	-0.381**	-0.293
26-40	0.553***	0.550***	0.635**
>40	1.844***	1.833***	1.928***
Workload (ref. 11-25)			
0	0.611***	0.390+	0.625***
1-10	0.264	0.004	0.278
26-40	0.017	-0,082	0.011
>40	1.021**	0.934*	1.014*
2021 (ref. 2020)	0.896***	0.547**	1.085***
Workload # Year			
0 # 2021		0.481	
1-10 # 2021		0.513	
26-40 # 2021		0.176	
>40 # 2021		0.175	
Study load # Year			
0 # 2021			-1.453*
1-10 # 2021			-0.198
26-40 # 2021			-0.211
>40 # 2021			-0.215
Constant	20.870***	21.022***	20.842***
Observations	8,575	8,575	8,575
R2	0.095	0.095	0.095

*Note: Unstandardized regression coefficients, + p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001*

Table 3: Multiple linear regression, dependent variable depressive symptoms, with the overall category of non-working students

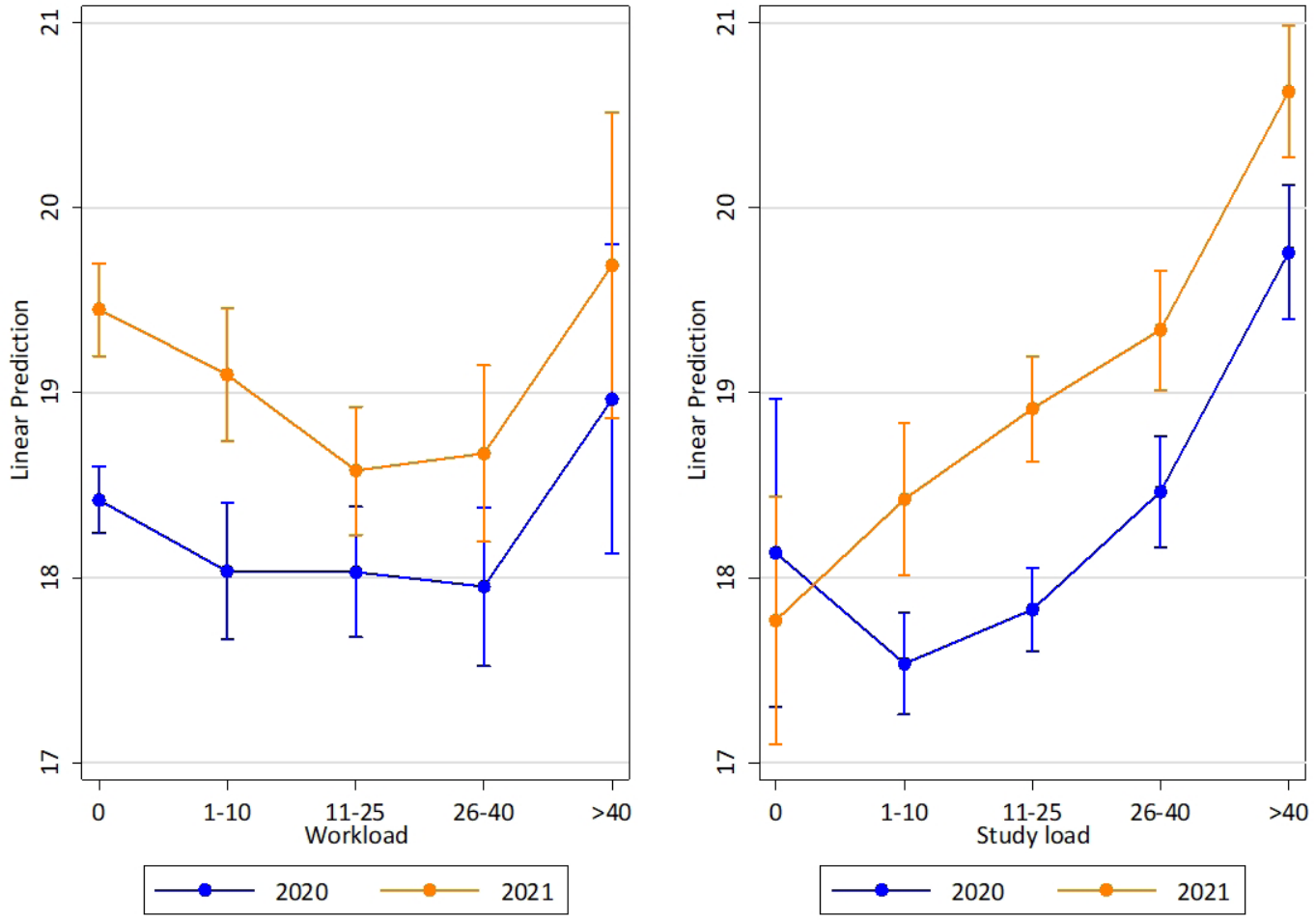

Figure 2: Multilevel linear regression, predicted values for depressive symptoms, *N* = 8,575

Job loss during the Covid-19 pandemic and its effect on mental health in students

Previous results suggest that students without jobs suffered from more depressive symptoms than working students (except for those working excessive working hours). We wanted to take a closer look and split the category of non-working students into those employed before the Covid-19 outbreak but no longer working during the pandemic and those who did not have a job before or after the pandemic (Table 4 and Figure 3). The difference between this table and the previous table (Table 3) lies in the use of a different variable for the workload – the variable in Table 4 distinguishes between students who declared zero hours worked before the pandemic and during the pandemic as well ("No job before covid-19") and students who worked at least some hours before the pandemic but declared zero hours worked during the pandemic ("No longer working during covid"). The regression models with more details (such as confidence intervals) can be found in Appendix D. The results show that both students who stopped working during the Covid-19 pandemic ($\beta = 0.804$; $p < .001$) and students who never had a job ($\beta = 0.442$; $p < .01$) had significantly higher depressive symptoms than working students. The results regarding study load, year of data collection, and control variables remained almost the same as in the previous models (Table 3).

	(1)	(2)
	CES-D8	CES-D8
Female (ref. male)	0.595***	0.601***
Age	-0.002	-0.002
Academic field (ref. Professions)		
Humanities	0.976***	0.967***
Soc. Sci.	0.237	0.234
Nat. Sci.	0.188	0.183
IT	0.293	0.270
Medicine	0.016	0.009
Degree (ref. Bachelor stud.)		
Master stud.	-0.474***	-0.483***
PhD stud.	-1.211***	-1.217***
Has a confidant (ref. No confidant)	-4.120***	-4.115***
Study load (ref. 11-25)		
0	-0.529+	-0.541+
1-10	-0.372*	-0.379**
26-40	0.555***	0.552***
>40	1.849***	1.827***
Workload (ref. 11-25)		
No job before covid	0.442**	0.300
No longer working during covid	0.804***	0.464*
1-10	0.261	0.004
26-40	0.023	-0.080
>40	1.103**	0.935*
2021 (ref. 2020)	0.923***	0.548*
Workload # Year		
No job before covid # 2021		0.265
No longer working during covid # 2021		0.935**
1-10 # 2021		0.509
26-40 # 2021		0.183
>40 # 2021		0.184
Constant	20.942***	20.145***
Observations	8,575	8,575
R2	0.096	0.096

*Note: Unstandardized regression coefficients, + p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001*

Table 4: Multiple linear regression, dependent variable depressive symptoms, non-working students split into "No job before covid-19" and "No longer working during covid"

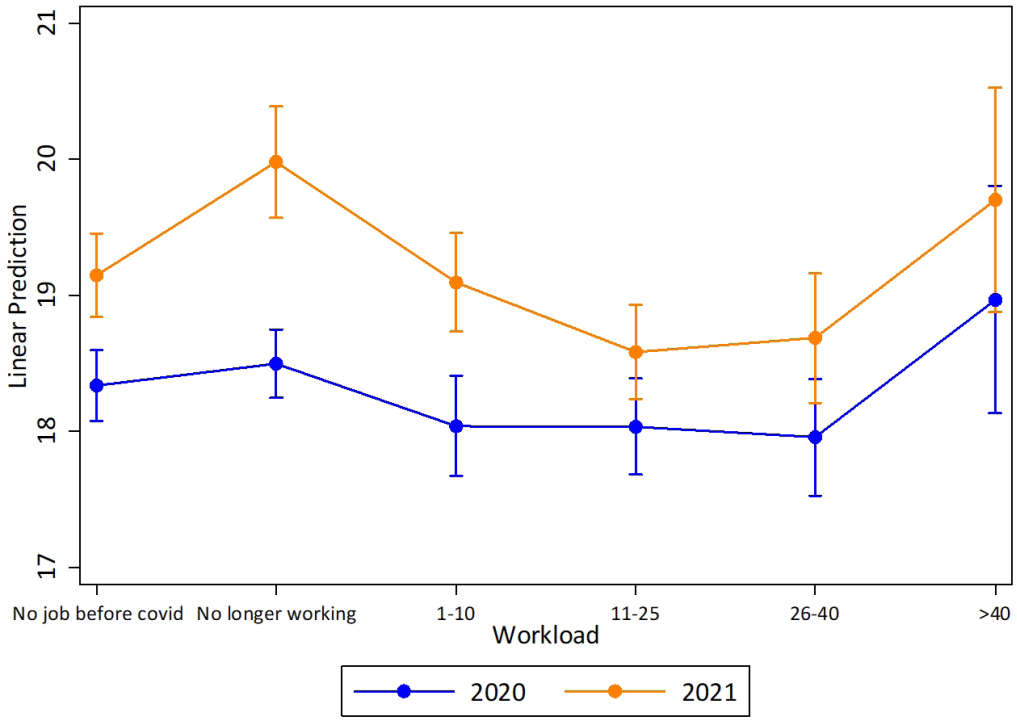

Figure 3: Multiple linear regression, predicted values for depressive symptoms, N = 8,575

Working students with substantial study loads

Moreover, since the expectations included an assumption that students with an excessive study load would have worse mental health than students without work but with the same excessive study load, we also constructed a model considering interactions between study load and workload (Figure 4 and Table with regression coefficients in Appendix E). Our findings, however, suggest that working students, even those working overtime with high study loads, had similar levels of depressive symptoms as non-working students with high study loads.

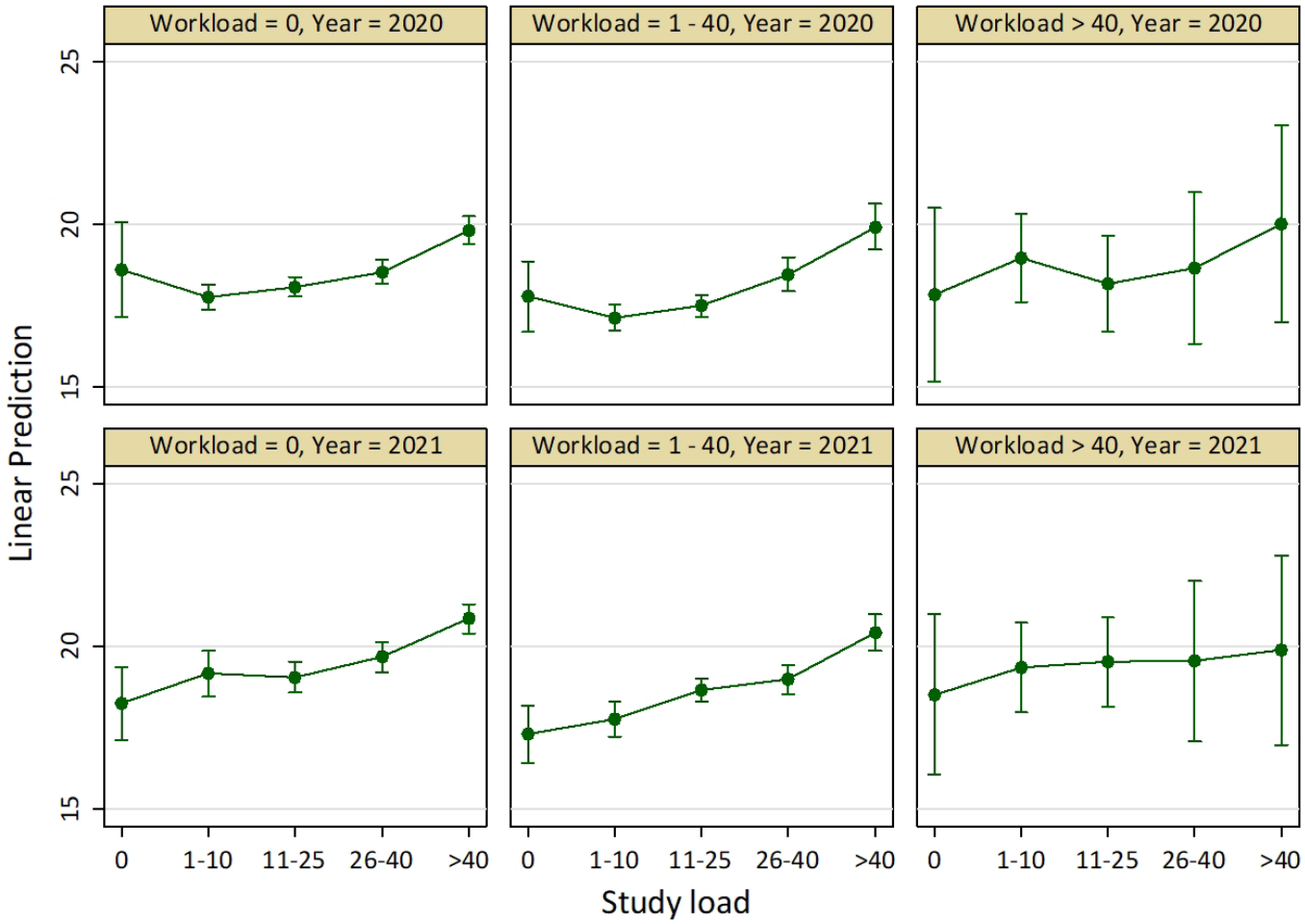

Figure 4: Multilevel linear regression, predicted values for depressive symptoms, N = 8,575

DISCUSSION

Based on the previous literature and theoretical background on role overload and role enrichment, we predicted that working university students would exhibit fewer depressive symptoms than students without any working commitments (H1), students working excessive hours would declare more depressive symptoms than students working up to 40 hours per week (H2), heavy study load would prove harmful to the mental well-being of the students (H3), students experiencing job loss would manifest worse mental health (H4), and students with excessive study and workload would suffer from significantly higher depressive symptoms than a student with a high level of study but without any kind of paid work (H5). Our hypothesis regarding differing degrees of mental distress for non-working students and those working up to a regular 40-hour week (H1) was confirmed in our study and is also in concordance with the previous literature, which clearly states that working students benefit from lower depressive symptomatology (Barros et al., 2022; Curtis and Shani, 2002; Nicklin et al., 2019). This is no surprise because work experience provides students not only with money to elevate their financial security and decrease stress levels (Monk, 2004; Stanley and Manthorpe, 2002) and important skills (Curtis and Shani, 2002; Nicklin et al., 2019) but also affords social contact, which was so very precious during the lockdowns in 2020 and 2021. Also, this finding is in concordance with the assumption that employment is benefiting students. In line with our expectation (H2) and the existing evidence (Ogawa et al., 2018; Wong et al., 2019), the results indicate that students working more than 40 hours per week have significantly worse mental health than other working students. When focusing on Figure 2, signs suggest that the coefficient is high and exceeds the other working groups. Because the literature shows an increase in study load among students during the pandemic (Lemay et al., 2021), and there is evidence suggesting that combining work and study can be stressful

(Jogaratnam and Buchanan, 2004) and, therefore, also harmful to overall well-being, we anticipated a heavy study load to be detrimental to students' mental well-being (H3). This expectation was met. The association between study load and mental distress was positive and linear for 2020 and 2021. We were also interested in the effect of job loss and its relationship with depressive symptomatology (H4). In line with previous literature (Flint et al., 2013; Paul and Moser, 2009), we found a significant association between job loss (students who were no longer working during the pandemic) and worse mental health. Students who lost their jobs exhibited significantly higher depressive symptoms than students working part-time and full-time. Our findings also do not support the expectation we formulated based on the theory of role overload that working students with substantial study loads would suffer from higher mental distress compared to non-working students with a substantial study load (H5). This may also be attributed to selection bias. While it is possible the share of students with such extensive working hours is negligible, it is also likely that this limit stems from our data sample and that we did not succeed in recruiting enough diverse student groups. Another possible explanation might be an influence of some other factor that was not captured by our questionnaire.

Limitations

Despite our study's advantages, such as the focus on the understudied university student population in the special circumstances of the Covid-19 pandemic during two time periods and considering potentially complementary theoretical backgrounds, it is not without limitations. Although the sample size is more than satisfactory, we were limited by the mode of collection (online survey) and the selection of universities that participated. This might have also caused selection bias, which has been mentioned several times. Moreover, the sample does not meet the criteria for representativeness: about two-thirds are women, and more than forty percent of the academic fields of study are professions. This limits the generalization of the conclusions. The data analyzed have cross-sectional characteristics, yet a panel survey would have been ideal for our purposes. Also, the study design did not allow us to establish the causal links between our dependent and independent variables. The explanation is two-fold: students without a job could be more prone to depressive than students with a job, or the students were too depressed to work. Furthermore, we used only one psychological instrument in our analysis; introducing more instruments that would measure, for example, anxiety or positive affect could bring more insight into the relationship between our dependent and independent variables. Similarly, due to the limited scope of the questionnaire, we were able to measure role enrichment and role overload, each by a single variable expressing the time invested in it. Even though that is not ideal, and this drawback should be addressed in future studies, we believe that our study offers interesting and valuable findings despite that. In both surveys, there were different universities with different characteristics. For example, our 2021 sample contained more medical students and fewer students studying in professional academic fields than the 2020 sample. Even though the data collection happened around the same time, each survey had specific circumstances. The year 2020 captured the beginning of the pandemic, and this year was more uncertain, with only a few Covid-19 cases. In 2021, significantly more people were infected, yet the restrictions were easing up at that time. The students were mainly in the exam period or transitioning towards the exam period, which might also be an exceptionally stressful situation that contributed to overall poor mental health among students. Therefore, the results relating to tentative comparisons between the years must be considered cautiously.

CONCLUSION

The study aimed to explore the relationship between hours worked, hours dedicated to the study and subjectively reported depressive among Czech University students during two-time points during the COVID-19 period. Our findings suggest that students who work during the term experience enrichment, at least in the sense of lowered mental health distress, compared to students without a job. When interpreting the results on study load, in general, more hours spent studying tend to result in a more pronounced negative effect on depressive symptomatology. Excessive hours worked seem to have a significant effect on depressive symptomatology in students. Students who had lost their jobs and students who had never worked had similar levels of depressive symptomatology (higher than working students). Role overload expectations applied to students with heavy work and study loads also do not seem to apply to Czech students during the pandemic. Today's students are the future. They will soon become the working population and have to bear the burden of contributing to the pension system and providing for an aging population. But because they are often already forced by the circumstances to work while studying and are becoming overloaded, their already severely compromised mental health suffers even more. Despite the clearly stated limitations, this study contributes to understanding the complex relationship between work, study, and mental health among university students. While the combination of study and work can be beneficial to some extent, too much of everything is harmful. Our results have important implications for developing strategies to support students in managing their work-study balance to maintain their mental health. They also inform the development of educational policies and student support services, which can help create a more equitable and supportive environment for all students. Future research should ideally include a multi-country comparison of the general student population in a normal situation and distinguish among different types of jobs.

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DATA AVAILABILITY STATEMENT

A detailed description of the C19 ISWS data collection (2020) is available in the Scandinavian Journal of Public Health (Van de Velde et al., 2021), and the cross-sectional multicountry dataset including the Czech Republic is freely accessible on Zenodo (Buffel & Velde, 2022) . The Czech dataset from 2021 is publicly available at the Czech Social Science Data Archive: Soukup, Petr; Kudrnáčová, Michaela; Klusáček, Jan, 2023, "University students during COVID-19 pandemic (Vysokoškolští studenti během pandemie)", https://doi.org/10.14473/CSDA/NCKCXO, CSDA, V1. The ČSDA research infrastructure project is supported by the Ministry of Education, Youth and Sports within the framework of grant LM2018135.

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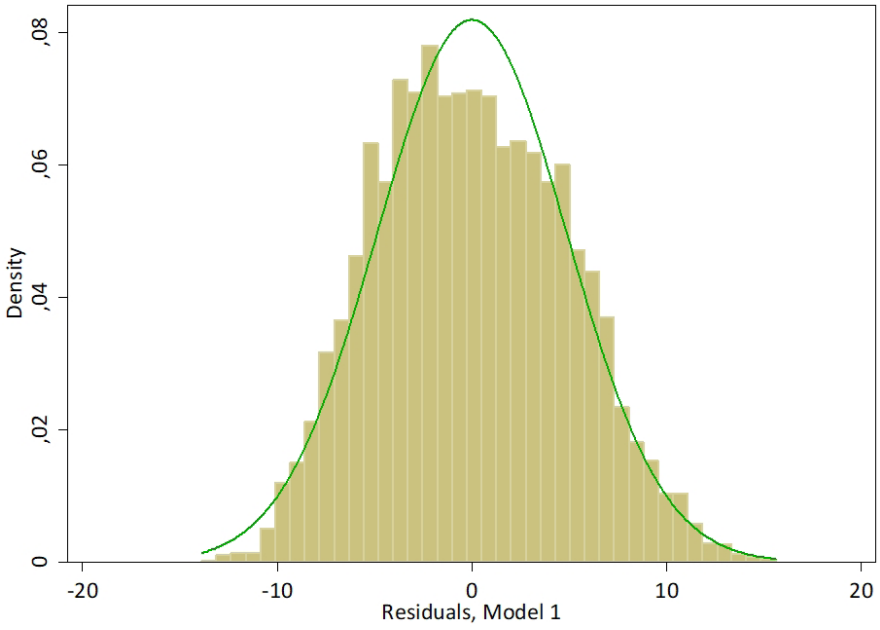
APPENDIX

APPENDIX A. VIF VALUES FOR BASELINE MODEL IN TABLE 3

	VIF
Female (ref. male)	1.09
Age	1.62
Academic field (ref. Professions)	
Humanities	1.21
Soc. Sci.	1.13
Nat. Sci.	1.25
IT	1.16
Medicine	1.30
Degree (ref. Bachelor)	
Master	1.39
PhD	1.39
Study load (ref. 11-25)	
0	1.10
1-10	1.29
26-40	1.29
>40	1.33
Workload (ref. 11-25)	
0	2.01
1-10	1.62
26-40	1.52
>40	1.18
2021 (ref. 2020)	1.11

APPENDIX B. HISTOGRAM OF THE RESIDUALS, MODEL 1 IN TABLE 3



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APPENDIX C. MULTIPLE LINEAR REGRESSION, DEPENDENT VARIABLE DEPRESSIVE SYMPTOMS, WITH THE OVERALL CATEGORY OF NON-WORKING STUDENTS

	(1)	95% Conf. Interval		(2)	95% Conf. Interval		(3)	95% Conf. Interval	
	CES-D8			CES-D8			CES-D8		
Female (ref. male)	0.610***	0.372	0.848	0.616***	0.378	0.854	0.608**	0.370	0.846
Age	0.002	-0.046	0.050	0.003	-0.045	0.051	-0.001	-0.048	0.048
Academic field (ref. Professions)									
Humanities	0.979***	0.649	1.308	0.983***	0.654	1.312	0.975***	0.646	1.304
Soc. Sci.	0.236	-0.136	0.608	0.240	-0.132	0.612	0.239	-0.133	0.611
Nat. Sci.	0.168	-0.128	0.463	0.166	-0.129	0.462	0.152	-0.143	0.448
IT	0.267	-0.168	0.701	0.249	-0.186	0.684	0.269	-0.165	0.704
Medicine	-0.021	-0.405	0.361	-0.039	-0.423	0.345	-0.033	-0.417	0.352
Degree (ref. Bachelor)									
Master	-0.473***	-0.722	-0.225	-0.480***	-0.729	-0.231	-0.476***	-0.725	-0.227
PhD	-1.228***	-1.790	-0.665	-1.233***	-1.796	-0.671	-1.234***	-1.798	-0.672
Has a confidant (ref. No confidant)	-4.120***	-4.508	-3.732	-4.118***	-4.506	-3.730	-4.119	-4.507	-3.731
Study load (ref. 11-25)									
0	-0.540	-1.094	0.014	-0.556*	-1.111	-0.002	0.307	-0.557	1.171
1-10	-0.371*	-0.660	-0.083	-0.381**	-0.669	-0.092	-0.293	-0.646	0.061
26-40	0.553***	0.272	0.835	0.550***	0.268	0.831	0.635**	0.263	1.006
>40	1.844***	1.531	2.158	1.833***	1.518	2.147	1.928***	1.504	2.353
Workload (ref. 11-25)									
0	0.611***	0.318	0.904	0.390+	-0.008	0.787	0.625***	0.332	0.919
1-10	0.264	-0.094	0.621	0.004	-0.504	0.512	0.278	-0.079	0.636
26-40	0.017	-0.388	0.422	-0,082	-0.632	0.469	0.011	-0.393	0.416
>40	1.021**	0.381	1.661	0.934*	0.028	1.840	1.014*	0.374	1.655
2021 (ref. 2020)	0.896***	0.676	1.117	0.547**	0.053	1.041	1.085***	0.722	1.449
Workload # Year									
0 # 2021				0.481	-0.096	1.059			
1-10 # 2021				0.513	-0.198	1.225			
26-40 # 2021				0.176	-0.618	0.970			
>40 # 2021				0.175	-1.089	1.439			
Study load # Year									
0 # 2021							-1.453*	-2.577	-0.330
1-10 # 2021							-0.198	-0.805	0.408
26-40 # 2021							-0.211	-0.778	0.355
>40 # 2021							-0.215	-0.829	0.399
Constant	20.870***	19.703	22.038	21.022***	19.831	22.215	20.842***	19.671	22.012
Observations	8,575			8,575			8,575		
R^2	0.095			0.095			0.095		
AIC	51527.20			51531.76			51528.67		
BIC	51668.33			51701.12			51698.03		

*Note: Unstandardized regression coefficients, + p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001*

APPENDIX D. MULTIPLE LINEAR REGRESSION, DEPENDENT VARIABLE DEPRESSIVE SYMPTOMS, NON-WORKING STUDENTS SPLIT INTO "NO JOB BEFORE COVID-19" AND "NO LONGER WORKING DURING COVID"

	(1)	95% Conf. Interval		(2)	95% Conf. Interval	
	CES-D8			CES-D8		
Female (ref. male)	0.595***	0.357	0.833	0.601***	0.362	0.839
Age	-0.002	-0.050	0.046	-0.002	-0.050	0.046
Academic field (ref. Professions)						
Humanities	0.976***	0.647	1.305	0.967***	0.638	1.297
Soc. Sci.	0.237	-0.135	0.609	0.234	-0.138	0.606
Nat. Sci.	0.188	-0.108	0.483	0.183	-0.113	0.479
IT	0.293	-0.142	0.727	0.270	-0.165	0.705
Medicine	0.016	-0.368	0.401	0.009	-0.376	0.394
Degree (ref. Bachelor stud.)						
Master stud.	-0.474***	-0.723	-0.225	-0.483***	-0.732	-0.234
PhD stud.	-1.211***	-1.773	-0.648	-1.217***	-1.780	-0.655
Has a confidant (ref. No confidant)	-4.120***	-4.508	-3.732	-4.115***	-4.503	-3.727
Study load (ref. 11-25)						
0	-0.529+	-1.083	0.025	-0.541+	-1.095	0.013
1-10	-0.372*	-0.660	-0.083	-0.379**	-0.667	-0.090
26-40	0.555***	0.274	0.837	0.552***	0.271	0.834
>40	1.849***	1.536	2.163	1.827***	1.513	2.142
Workload (ref. 11-25)						
No job before covid	0.442**	0.119	0.765	0.300	-0.139	0.740
No longer working during covid	0.804***	0.472	1.136	0.464*	0.032	0.895
1-10	0.261	-0.096	0.618	0.004	-0.504	0.512
26-40	0.023	-0.382	0.427	-0.080	-0.630	0.471
>40	1.103**	0.386	1.665	0.935*	0.029	1.841
2021 (ref. 2020)	0.923***	0.702	1.145	0.548*	0.054	1.041
Workload # Year						
No job before covid # 2021				0.265	-0.367	0.898
No longer working during covid # 2021				0.935**	0.250	1.620
1-10 # 2021				0.509	-0.202	1.220
26-40 # 2021				0.183	-0.610	0.977
>40 # 2021				0.184	-1.080	1.447
Constant	20.942***	19.773	22.110	20.145***	19.951	22.338
Observations	8,575			8,575		
R^2	0.096			0.096		
AIC	51523.30			51524.73		
BIC	51671.49			51708.20		

*Note: Unstandardized regression coefficients, + p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001*

APPENDIX E. MULTIPLE LINEAR REGRESSION, DEPENDENT VARIABLE DEPRESSIVE SYMPTOMS

	CES-D8	95% Conf. Interval	
Gender			
Female (ref. male)	0.614***	0.375	0.852
Age	-0.005	-0.051	0.044
Academic field (ref. Professions)			
Humanities	0.992***	0.664	1.320
Soc. Sci.	0.241	-0.131	0.613
Nat. Sci.	0.176	-0.120	0.472
IT	0.265	-0.170	0.700
Medicine	-0.019	-0.404	0.366
Degree (ref. Bachelor stud.)			
Master stud.	-0.473***	-0.723	-0.224
PhD stud.	-1.210***	-1.774	-0.645
Has a confidant (ref. No confidant)	-4.120***	-4.509	-3.731
Study load (ref. 11-25)			
0	0.537	-0.954	2.028
1-10	-0.311	-0.800	0.178
26-40	0.470+	-0.002	0.941
>40	1.744***	1.228	2.261
Workload # Year (0 # 2020)			
1 - 40 # 2020	-0.572*	-1.028	-0.116
>40 # 2020	0.098	-1.409	1.605
0 # 2021	0.972**	0.416	1.527
1 - 40 # 2021	0.578*	0.103	1.053
>40 # 2021	1.441*	0.039	2.843
Study load # Workload # Year			
0 # 1 - 40 # 2020	-0.260	-2.133	1.614
0 # >40 # 2020	-0.963	-4.246	2.519
0 # 0 # 2021	-1.349	-3.272	0.573
0 # 1 - 40 # 2021	-1.900*	-3.666	-0.134
0 # >40 # 2021	-1.547	-4.736	1.642
1-10 # 1 - 40 # 2020	-0.060	-0.779	0.658
1-10 # >40 # 2020	1.094	-0.967	3.155
1-10 # 0 # 2021	0.424	-0.556	1.403
1-10 # 1 - 40 # 2021	-0.575	-1.382	0.232
1-10 # >40 # 2021	0.133	-1.862	2.129
26-40 # 1 - 40 # 2020	0.495	-0.288	1.277
26-40 # >40 # 2020	0.014	-2.775	2.804
26-40 # 0 # 2021	0.149	-0.671	0.968
26-40 # 1 - 40 # 2021	-0.146	-0.887	0.595
26-40 # >40 # 2021	-0.445	-3.300	2.411
>40 # 1 - 40 # 2020	0.679	-0.252	1.609
>40 # >40 # 2020	0.102	-3.304	3.509
>40 # 0 # 2021	0.054	-0.769	0.877
>40 # 1 - 40 # 2021	0.026	-0.820	0.871
>40 # >40 # 2021	-1.392	-4.621	1.837
Constant	21.562***	20.428	22.696
Observations	8,575		
R^2	0.095		

*Note: Unstandardized regression coefficients, + p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001*

Full research paper

THE ROLE OF ACADEMIC RESILIENCE, SELF-REGULATION, AND PERCEPTIONS OF CHEMISTRY STUDENTS IN ACADEMIC ACHIEVEMENT: A STRUCTURAL EQUATION MODELLING (SEM) APPROACH

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ABSTRACT

Improving student achievement is one of the most important components of learning, and it is influenced by several variables, including academic resilience, self-regulation, and students' perceptions. This study examined how high school academic resilience, self-regulation, and students' perceptions affect their academic achievement in chemistry classes. Even though chemistry is regarded as a crucial subject for learning, most students find it complicated, making it challenging to comprehend. This explains why students' academic achievement in chemistry is so low. Using cluster random sampling techniques, 791 students participating in chemistry classes formed the sample. The linear relationship model between academic resilience, self-regulation, student perceptions, and achievement in chemistry is examined in this research using the Structural Equation Modelling (SEM) method. The results indicate that chemical achievement correlates negatively with academic resilience, significantly positively with self-regulation, and negatively and insignificantly with student perception. To ensure that students in chemistry learn at their best, teachers should focus more on the qualities of their students and incorporate learning activities.

KEYWORDS

Academic resilience, achievement, chemistry, perception, self-regulation, structural equation modelling

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Highlights

- *Academic resilience shows a negative relationship with students' achievement in chemistry.*
- *Self-regulation has a significant positive effect on chemistry achievement.*
- *Students' perceptions of chemistry learning have no significant impact on achievement.*
- *Strengthening students' self-regulation skills may enhance cognitive outcomes in chemistry learning.*

INTRODUCTION

Education plays a major role in developing and expanding the human resources needed for nation-building. The reason is that education is an important component of human life and helps foster a morally and socially responsible, inventive, and civilized society (Taheri et al., 2016; Malik and Parveen, 2019). As Oyelekan et al. (2019) noted, students are an integral part of the teaching and learning process. Students' academic achievement is a reflection of the quality of their learning. Any education system aims to improve students' general abilities, especially academic achievement (Lim et al., 2022). Measuring students' academic achievement is very important because it can provide an overview of how students succeed in the learning process (Hussain et al., 2019).

Numerous obstacles to chemistry education in Indonesia impact learners' academic achievement. One of the primary issues is that students frequently struggle to comprehend abstract fundamental chemical ideas (Priliyanti et al., 2021).

This is because chemistry is a challenging subject that takes much practice and dedication to master (Moreno et al., 2021; Siddique et al., 2023). Various factors, such as psychological factors, can affect students' academic achievement in chemistry. Academic resilience, self-regulation, and student perception are some variables that have received attention from researchers.

Academic resilience, self-regulation, and students' perceptions of cognitive achievement are interrelated elements and one of the important factors for success in chemistry learning. Academic resilience enables students to better deal with problems in chemistry studies (Annisa et al., 2023). Meanwhile, self-regulation in chemistry lessons allows students to efficiently and autonomously oversee the learning process (Feldman-Maggor, 2023) studies show that this flexibility also poses a challenge for individual learners who are required to manage their schedules and complete specific tasks independently. Therefore, success in an online learning environment relies heavily on the learner's self-regulated learning (SRL. Students with good self-regulation skills tend to be more confident in understanding chemistry concepts, which ultimately increases their perceptions of cognitive achievement (Ataii et al., 2021). Perceived competence plays a mediating role in the relationship between self-regulation and academic resilience so that students remain motivated to succeed despite facing difficult material (Kiliç et al., 2022). Therefore, problems arise when students cannot face learning challenges, low self-regulation skills, and poor perceptions of their cognitive abilities in chemistry that hinder their overall achievement.

This study provides major contributions. First, research on academic resilience can improve student achievement, considering resilient individuals can overcome obstacles and adapt to new environments. Second, research on self-regulation can improve students' motivation to learn because students have a personal task to learn to achieve positive learning outcomes and improve their quality of life. Third, research on student perception can affect memory, idea generation, and attitude development, all of which affect response activities in the learning process. As a result, if these three contributions function well, it is expected that the academic achievement of chemistry students can increase.

THEORETICAL FRAMEWORK AND HYPOTHESES

Academic Resilience and Academic Achievement

Research on the role of resilience in improving the cognitive achievement of chemistry students in Indonesia is increasingly in demand, given how important resilience is for academic success (Annisa et al., 2024a). This is a key factor in developing academic resilience, as giving students individual targets or goals can help them become more resilient as they will be challenged to overcome obstacles, peer pressure, and self-doubt (Finklestein et al., 2022). Academic resilience is part of general adaptability that relates to how difficult it is for an individual to adjust to various requirements, courses, and fields of study (Deng et al., 2023). This is because chemistry is often considered complicated and abstract in achieving educational goals (Timilsena et al., 2022).

Several studies have shown that student resilience highly depends on their intelligence level (Huang et al., 2022). There are numerous articles on academic resilience. However, the relationship between student learning achievement in chemistry and academic resilience has not been well-researched (Annisa et al., 2023). Theoretically, though, academic resilience may influence students' learning outcomes. A person with a high level of resilience may learn more effectively because they can overcome various obstacles in learning (Peker and Cengiz, 2022). Another study revealed that motivation and academic resilience significantly predicted achievement in chemistry (Chikendu et al., 2021). This is in line with the findings of Oke et al. (2016), which showed a significant correlation between academic resilience and academic achievement across groups. Another study involving high school students in mathematics found that students had varying levels of resilience based on grade level, suggesting that students' perceptions of their academic resilience in mathematics may change as they progress (Ishak et al., 2020). Similarly, Jamaluddin et al. (2023) investigated the resilience of biology students and found a correlation between academic resilience and the development of critical thinking skills.

Spirituality, emotional regulation, and self-reflection are all important components of academic resilience (Cherian and Kumari, 2021). Academic resilience has many subdimensions, such as spirituality, emotional regulation, and self-reflection, which are particularly beneficial. Spirituality is primarily concerned with finding greater meaning and "purpose in life," as well as personal pursuit and progress. Students with high spirituality are better able to cope with stress, adapt, and think positively about difficult circumstances (Gnanaprakash, 2013). According to Saefudin and Sriwiyanti (2023) during the education and rehabilitation process, juveniles experience adverse psychological states and encounter external difficulties. Therefore, the juveniles must have stress resistance or resilience to deal with these issues, as well as spiritual well-being which provides a holistic perspective on an individual's existence and facilitates a more comfortable understanding of life. This broad perspective empowers the individual to manage challenging conditions, including the educational environment. Therefore, this study assumed that spiritual well-being affects student academic resilience. Researchers employed the proportionate stratified random sampling approach. There were 100 juvenile respondents. The enrollment criteria include juveniles aged 12 to 18 who perpetrated various criminal offenses, served their sentences in prisons, and participated in the institution's educational program. The results are categorized into two principal findings discussions. First, the academic resilience of juveniles is found to be 75% high and 25% moderate. Second, spiritual well-being correlates with students' academic resilience, and the regression analysis results depict that spiritual well-being can explain 42.6% of academic resilience. These results indicate that spiritual well-being enhances academic resilience during study in prison.\r \r Abstrak. Lembaga Pembinaan Khusus Anak (LPKA, worship is students' main spiritual method to cope with school-related anxiety. Students can manage their feelings better, resulting in increased resilience and overall well-being. This is a result of emotional regulation, specifically emotional

maturity. Higher distress tolerance results from adaptive emotion regulation strategies, indicating how important these strategies are in dealing with academic challenges (Chen, 2022). In addition, emotional regulation, specifically emotional maturity, helps students manage their feelings well, resulting in better resilience and well-being (Annisa et al., 2024b). Reflective thinking significantly increases academic resilience and well-being, particularly among language learners, highlighting the importance of self-evaluation in fostering persistence (Hammad Al-Rashidi and Aberash, 2024) both self-evaluation (SE). Salem (2024) also found that students who engaged in self-reflection on their technological competencies developed stronger academic resilience, particularly in STEM fields. These subdimensions work together to build a resilient mindset and provide students with the tools they need to thrive in the face of academic challenges.

Self-Regulation and Academic Achievement

Self-regulated learning is still an interesting research topic for psychologists and educators (Khan et al., 2020). Self-regulated learning (SRL) is very important in chemistry education in Indonesia because it affects students' academic outcomes and achievements (Fazriah et al., 2021). Another study emphasized the importance of SRL in a laboratory environment, which showed that SRL significantly affected students' motivation and engagement during practical activities (Purwoko et al., 2024). Web-based learning can significantly improve students' self-regulated learning, leading to enhanced chemistry academic achievements (Indriani et al., 2023). In addition, metacognition and motivation are important components that influence students' success and persistence in chemistry education (Rahmawan et al., 2024). These results indicate that developing self-regulation skills is essential to improving students' performance and engagement in chemistry learning. Self-regulation positively impacts academic achievement (Xiao et al., 2019; Wandler and Imbriale, 2017). Environment, time management, and metacognitive activities significantly impact academic achievement (Lee et al., 2020). These insights suggest that educational approaches that enhance self-regulated learning skills are needed for Indonesian chemistry students to be more resilient and achieve.

In addition to chemistry, other studies have shown that self-regulation is essential for students in physics, biology, mathematics, and science, allowing them to manage their thoughts, behaviors, and emotions to navigate learning (Paz-Baruch and Hazema, 2023). Self-regulated learning involves managing cognitive, behavioral, metacognitive, affective, and motivational aspects to achieve educational goals. In mathematics, self-regulation is associated with improved problem-solving abilities (Říčan et al., 2022). Additionally, studies show that students who practice self-regulation experience decreased procrastination and stress, which positively impacts their academic performance (García-Ros et al., 2023). Students in mathematics show better attitudes toward learning. In addition, self-regulation is related to critical thinking, which is important for processing information in science education (Higgins et al., 2023)whether SRL improves as students gain educational experience in undergraduate science has not been adequately studied. It is also unclear whether traditionally strong predictors of academic performance, such as the Australian Tertiary Admissions Rank (ATAR).

Self-regulation is a fundamental psychological process that allows individuals to control their behavior, emotions, and cognitions to achieve goals. It is closely related to self-planning, impulse control, and motivation. Self-planning, as a component of self-regulation, involves setting structured strategies to guide behavior, such as implementation intentions, which have been shown to reduce impulsive decision-making (Thürmer et al., 2020). Impulse control, another dimension of self-regulation, is critical in reducing automatic behaviors driven by external stimuli, as failures in self-regulation often occur when self-control resources are depleted (Gnanaprakash, 2013). In addition, motivation interacts with self-regulation by influencing the selection and implementation of self-regulation strategies. Research suggests that self-motivational and emotion-regulation strategies can enhance volitional control, thereby improving behavioral outcomes (Forstmeier and Rueddel, 2007). Self-regulated learning involves reflection, goal setting, and self-monitoring, which enhance students' ability to manage their learning (Clayton Bernard and Kermarrec, 2022). In addition, self-regulation includes regulating emotions, motivation, and cognitive control, which enables students to persist in complex learning tasks. Understanding these interrelated dimensions provides insight into how individuals can enhance their self-regulatory capacity to achieve long-term success.

Student's Perception of Chemistry and Academic Achievement

Perception is related to the five senses because it occurs after the object sees, hears, or feels something and organizes and interprets it. In addition, this process occurs in how students view learning in class to achieve achievement (Ansow et al., 2022). Perception is the ability to be aware of things, understand and analyze the surrounding environment, and categorize various types of information (Altundağ et al., 2022). To form a meaningful world perspective, perception must be understood as a job that involves focusing on sensory input and analyzing and interpreting it (Mannopovna, 2019).

In many countries, most students leave chemistry courses in high school and college due to the general opinion that the subject is challenging to understand and teach (Rosly et al., 2021). Many students still view chemistry as an abstract and difficult topic with no relevance to real life, even though it directly relates to it (Karsli Baydere, 2021). Students have difficulty understanding complex chemistry concepts, especially in organic chemistry and thermodynamics, which require a lot of visualization and symbolic representation (Oladejo et al., 2023). In addition, complex organic chemistry reaction mechanisms lead to student frustration and isolation (Salame and Khalil, 2023). Furthermore, Crossdale et al. (2022) found that female students are less likely to continue studying chemistry in high school because they experience difficulties and are not confident in their abilities in the field. Learning chemistry should make understanding the

chemical processes that occur in nature and the environment easier. Students argue that they should be able to apply the chemical information they gain in class to solve the difficulties they face in real life (Habibi et al., 2022; van Vorst and Aydogmus, 2021). To overcome students' lack of interest in chemistry, self-regulation and academic resilience can be effective strategies to increase engagement and understanding. Studies show that resilience, self-regulation, and a supportive learning environment improve students' academic performance. This helps them to deal with difficult chemical concepts (Machmud and Ramadhan, 2022). Self-regulation skills directly influence students' mathematics, chemistry, and physics performance. This suggests incorporating self-regulation strategies into the curriculum can increase students' interest and success in chemistry and physics lessons (Sultanova et al., 2024).

Chemistry students' perceptions are closely related to the dimensions of learning materials, learning attitudes, and learning concepts because these elements collectively shape their educational experience. These dimensions were chosen because they represent important aspects of the learning process that significantly influence chemistry students' engagement and learning outcomes (Masbukhin et al., 2023). For example, how students viewed online chemistry learning during the COVID-19 pandemic revealed that, although some found it easy and flexible, many found it poor due to uninteresting content and lack of readiness to participate online. This suggests that well-designed learning materials and positive learning attitudes are essential when learning online (Dewi et al., 2023). Incorporating ICT in chemistry education improves students' perceptions, making learning materials more interactive and accessible (Hairida et al., 2023). In addition, students introduced to the concept of "Green Chemistry" showed a deeper understanding and appreciation of sustainable practices, indicating how important this concept is in chemistry learning (Jusniar et al., 2023). These aspects cover a wide range of aspects that influence students' understanding and engagement with chemistry lessons, making them important for improving their understanding of chemistry learning.

Current Study

This study uses the Structural Equation Modeling (SEM) method, which is novel compared to commonly used approaches like ANOVA and simple linear regression in earlier research (Ghozali, 2011). This study attempts to provide greater insight into the factors that influence student accomplishment by utilizing SEM and synthesizing findings from prior studies. In essence, research focuses on statistics as a whole, which encompasses theories, procedures, and the analysis of statistical findings. This study investigated the following hypotheses.

H_1: Academic achievement is significantly impacted by the academic resilience of learning chemistry.

H_2: Academic achievement is significantly impacted by the self-regulation of chemistry learning.

H_3: Academic achievement is significantly impacted by students' perceptions of their chemistry learning.

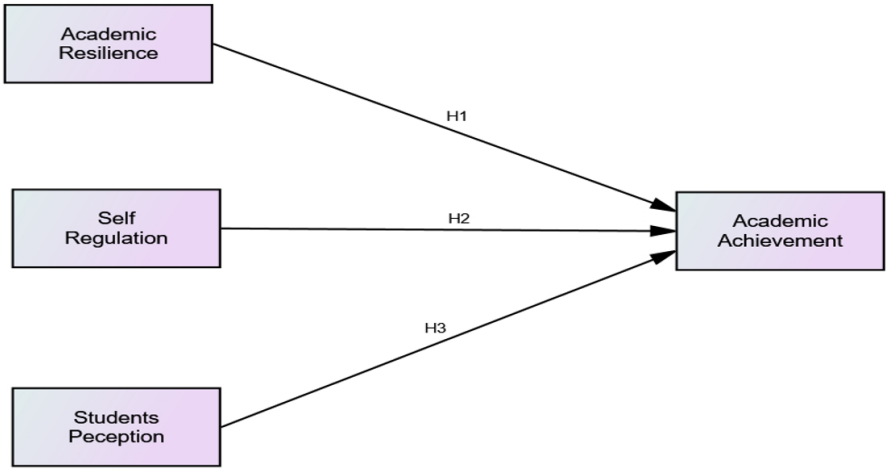

Figure 1: Research Framework

METHODS

Sample

The sample consisted of 791 high school students from 14 schools in Pekanbaru and its surrounding areas, Indonesia. For this study, a cluster random sampling technique was used to collect samples aged 15-17 years. There were 516 (65.23%) female students and 275 (34.77%) male students. This cross-sectional study involved high school students. The researcher was granted permission by the Provincial Education Office to conduct the study in 14 schools. Students from public schools majoring in science from grades one to three were the selected subjects. Before taking part in the study, students were given informed consent explaining the purpose and benefits of the study. They were also allowed to refuse or leave the study at any time. Student data was kept confidential and was used only for academic purposes by research ethics standards. Furthermore, the researcher sent a link to the questionnaire to the WhatsApp class to collect student responses.

Research Instrument

The items in the questionnaire come from previously published works, which are used as references in this study. The researcher synthesized the questionnaire items, namely academic resilience, which has been adopted by (Ramirez-Granizo et al., 2020; Idris et

al., 2019; Cassidy, 2016), then self-regulation assessment adapted by (Jakesova et al., 2016; Lehmann et al., 2014; Toering et al., 2012), and student perceptions adapted by (Agung et al., 2022; Ansow et al., 2022; Ngugi et al., 2020). The questionnaire was compiled based on several previously identified sub-dimensions. Academic resilience consists of spirituality, emotional regulation, and self-reflection. Self-regulation consists of self-planning, motivation, and impulse control, and student perception consists of learning materials, learning attitudes, and learning concepts. The interval from 1 (strongly disagree) to 5 (strongly agree) is used in this study as a Likert scale.

The procedure for working on the questionnaire is in section a (name, gender, school, and likes/dislikes of chemistry subjects) when respondents fill in the Google Form as their identity. In section B (11 items on cognitive achievement, 11 items in the statement section regarding academic resilience to chemistry learning, 11 items in the section on self-regulation regarding chemistry learning, and 11 items in the section on student perceptions of chemistry learning). The Cronbach's Alpha statistical technique is widely used to assess the reliability or internal consistency of research instruments such as questionnaires, tests, or surveys. This method determines how well a set of items can measure a unidimensional construct by looking at how correlated they are with each other (Tavakol and Dennick, 2011). The instrument has satisfactory internal consistency if the Cronbach's Alpha score exceeds 0.6 (Hair et al., 2019). Details can be seen in the following Table 1.

Variable /dimension	Code	Items	Internal reliability Cronbach Alpha
Academic resilience			0.788
Spirituality	RA49	I believe I will perform well and become successful if I surrender myself to the Lord.	0.757
	RA50	I pray before and after studying chemistry	0.763
	RA53	I reject an invitation to see my friend to skip a chemistry lesson	0.765
	RA54	I am choosing to do positive things like exercise, playing music, reading books, and drawing when I get a mark less in chemistry Good.	0.771
	RA57	I tend to panic when there are lots of urgent tasks in chemistry	0.765
	RA58	I finished in a way Alone exam chemistry although I did not understand about lesson.	0.778
Emotional control	RA51	I surrender just to get low value without praying to God for help	0.776
	RA55	I prefer to the canteen instead of attending chemistry lessons in class.	0.767
	RA60	I see a friend's answer when it's difficult to complete the chemistry exam.	0.787
Self-reflection	RA52	I do not give thanks to God when I get high value	0.769
	RA56	I was confused when my grades were bad and preferred to stay in my room.	0.791
Self-regulation			0.784
Self-planning	RD37	I remember and collect all information related to chemistry through book reading and discussion class	0.764
	RD38	I am learning chemistry repeatedly before the teacher teaches in class	0.762
	RD41	I like chemistry Because arouse curiosity for I although That difficult For studied.	0.765
	RD42	I think that important To learn material chemistry Because will be beneficial later day.	0.747
	RD45	I ask for help from Friends only when I feel difficulty in doing a task or when I find understanding material chemistry difficult.	0.770
	RD46	I ask for help from the teacher when difficult to question chemistry.	0.757
Academic motivation	RD43	I am certain that the material chemistry that I learn will be useful for me.	0.764
	RD47	I went out of class while studying chemistry	0.774
Impulse control	RD39	I have a hard time making plans to Study chemistry.	0.780
	RD44	I surrender to ethics and face material difficult chemistry	0.771
	RD48	I am embarrassed to ask the teacher when difficult question	0.789
Student's perception			0.854
Learning materials	PSB73	I understand material chemistry with Good when he learns interesting	0.839
	PSB74	I am interested in studying chemistry when the teacher uses various methods	0.834
	PSB78	Studying chemistry gives benefits in life on I daily	0.837
	PSB82	Studying chemistry That pleasant when We understand the material studied	0.837
Learning attitude	PSB75	I am more interested in the lessons other than lesson chemistry	0.850
	PSB76	I am not interested in studying chemistry If only listening to the teacher's lecture	0.846
	PSB79	I feel like I don't understand chemistry very well. because the material is complicated to learn	0.846
	PSB80	Learning chemistry is not enough beneficial for I	0.850
	PSB83	Studying chemistry is boring and makes me sleepy	0.843
Learning concept	PSB77	I often read chemistry teaching materials to increase my understanding of chemical materials I	0.843
	PSB81	My chemistry learning results improved because I Study with truly	0.836

Table 1: Research instrument

Data Analysis

The research model was tested using structural equation modeling in the IBM-SPSS AMOS 23.0 software. In the beginning, Confirmatory Factor Analysis (CFA) was utilized as construct confirmation (Khine et al., 2013). CFA assesses each construct measurement model based on four criteria: Construct Validity, Convergence Validity, Discriminant Validity, and Composite Reliability (CR).

Reliability and Validity of the Study

The measuring model's applicability was confirmed using Construct Validity, Convergent Validity CR, and Discriminant Validity. Convergent Validity of a construct is determined by calculating its Average Variance Extracted (AVE), which must be at least 0.5. However, if the CR is greater than 0.6 and the AVE is less than 0.5, the construct's convergent validity is still sufficient (Fornell and Larcker, 1981). The measuring model for a construct needs to satisfy CR standards regarding dependability requirements. According to Aimran et al. (2017), a minimum CR value of 0.60 is advised. The modification index shows that a construct's measurement model lacks superfluous components. When the measurement model lacks superfluous components, discriminant validity is attained. Construct Validity is confirmed using many computed Fitness Indices, such as Absolute Fit, Incremental Fit, and Parsimonious Fit. When one fitness index per category hits the target value, construct validity is established (Ahmad et al., 2016).

RESULTS

Description of analysis

The results show that the average cognitive achievement of students (M = 63.48, SD = 31.805) in the chemistry test was 34.77% male students and 65.23% female students. As can be shown in Table 2, the average student perception (M = 3.27, SD = 0.97), self-regulation (M = 3.41, SD = 0.91), and academic resilience (M = 3.50, SD = 0.97) in chemistry learning were recorded. Although in the same category, the average value of students' academic resilience towards chemistry was higher than that of self-regulation and students' perceptions towards the subject. This is shown in detail in Table 2 below.

Construct	Mean (M)	Standard Deviation (SD)
Academic resilience	3.50	0.97
Spirituality	3.35	0.92
Emotion control	3.53	0.95
Self-reflection	3.63	1.04
Self-regulation	3.41	0.91
Self-planning	3.25	0.83
Academic motivation	3.71	1.05
Impulse control	3.26	0.85
Student's perception	3.27	0.97
Learning materials	3.36	1.06
Learning attitude	3.17	0.87
Student learning concept	3.27	0.98

Table 2: Grade of Academic resilience, Self-regulation, and Students' perceptions of chemistry

Construct Validity Evaluation

Questionnaire on Academic Resilience

The 11-item academic resilience questionnaire is divided into three sub-dimensions: spirituality, emotional regulation, and self-reflection. The scale's final validity-reliability study involved 200 students, and the results showed that the overall Cronbach alpha reliability coefficient was 0.813, with the subscales of spirituality, emotional regulation, and self-reflection having the highest respective Cronbach alpha reliability coefficients of 0.796, 0.656, and 0.518. Chi-square criteria (χ^2/df ≤ 5, perfect fit; Hooper et al., 2008; Kline, 2016) and other goodness-of-fit indices (Goodness of Fit Index ≥ 0.90, acceptable; Tabachnick and Fidell, 2007), Comparative Fit Index (CFI ≥ 0.90, acceptable; Hooper et al. 2008), and Root Mean Square Error of Approximation (RMSEA ≤ 0.08, good; Hooper et al., 2008) can be used to assess the model's accuracy. Additionally, CFA results were confirmed for the academic resilience questionnaire, which has a three-factor scale structure. The results demonstrate appropriateness and reliability: χ^2/df = 1.812, GFI = 0.934, CFI = 0.950, and RMSEA = 0.064. Figure 1 below illustrates it in further detail.

Questionnaire on Self-Regulation

The 11-item self-regulation questionnaire is divided into three sub-dimensions: academic motivation, impulsive control, and self-planning. The Cronbach alpha reliability coefficient for each subscale was determined to be 0.876 (self-planning), 0.487 (academic motivation), and 0.674 (impulse control) in the scale's final validity-reliability study, which involved 200 students. The overall Cronbach alpha reliability coefficient was 0.816. The self-regulation questionnaire, which has a three-factor scale structure, yielded verified CFA results. Suitability and reliability are demonstrated by the values of χ^2/df = 2.087, GFI = 0.936, CFI = 0.954, and RMSEA = 0.074. Figure 2 below illustrates it in further detail.

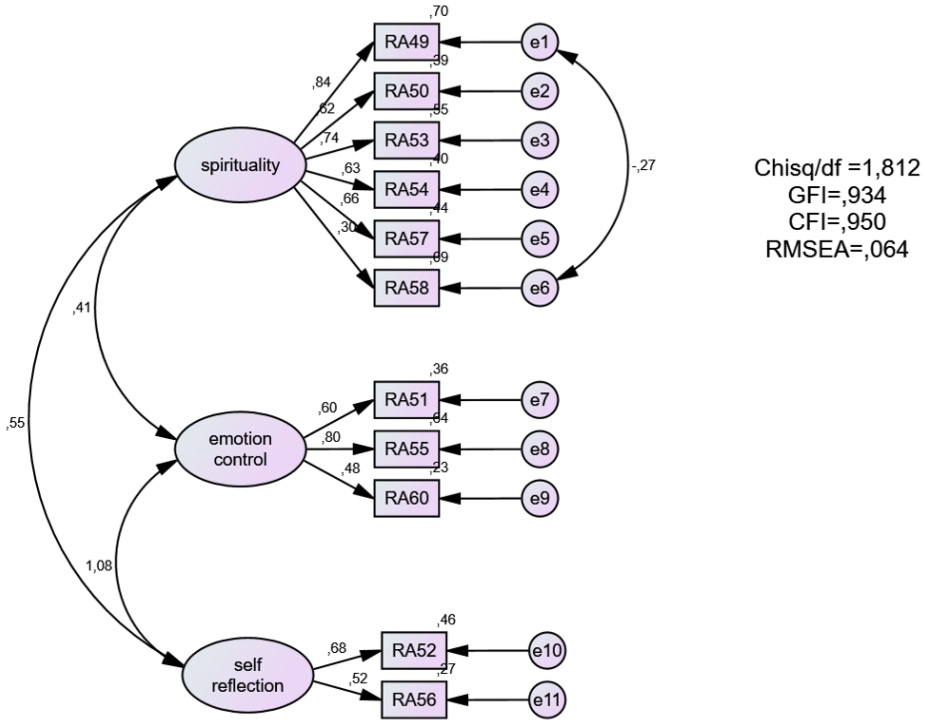

Figure 2: CFA for Academic Resilience

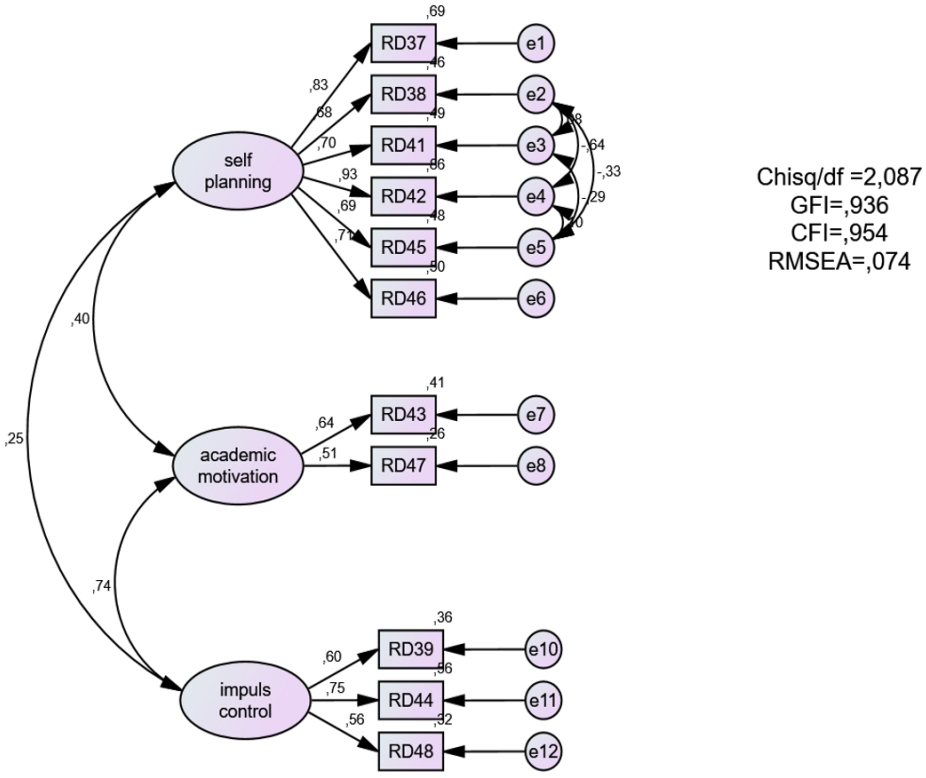

Figure 3: CFA for Self-Regulation

Questionnaire on Students' Perception

The 11-item student perception questionnaire is divided into three sub-dimensions: learning concepts, learning attitudes, and learning content. The Cronbach alpha reliability coefficient for each subscale was determined to be 0.847 (learning material), 0.789 (learning attitude), and 0.723 (learning concept) in the final validity-reliability study of the scale, which involved 200 students. The overall Cronbach alpha reliability coefficient was 0.859. The student perception questionnaire, which had a three-factor scale structure, yielded validated CFA results. Suitability and reliability are indicated by the obtained values of $\chi^2/df = 1.796$, GFI = 0.940, CFI = 0.967, and RMSEA = 0.063. Figure 3 below shows it in further depth.

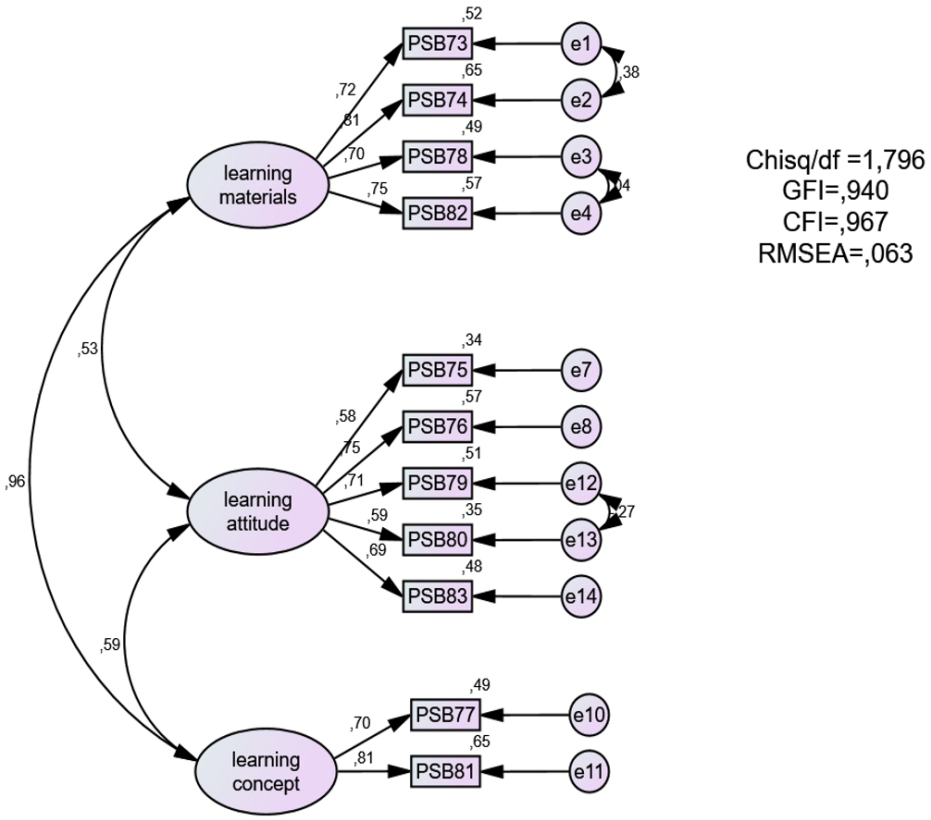

Figure 4: CFA Students Perception

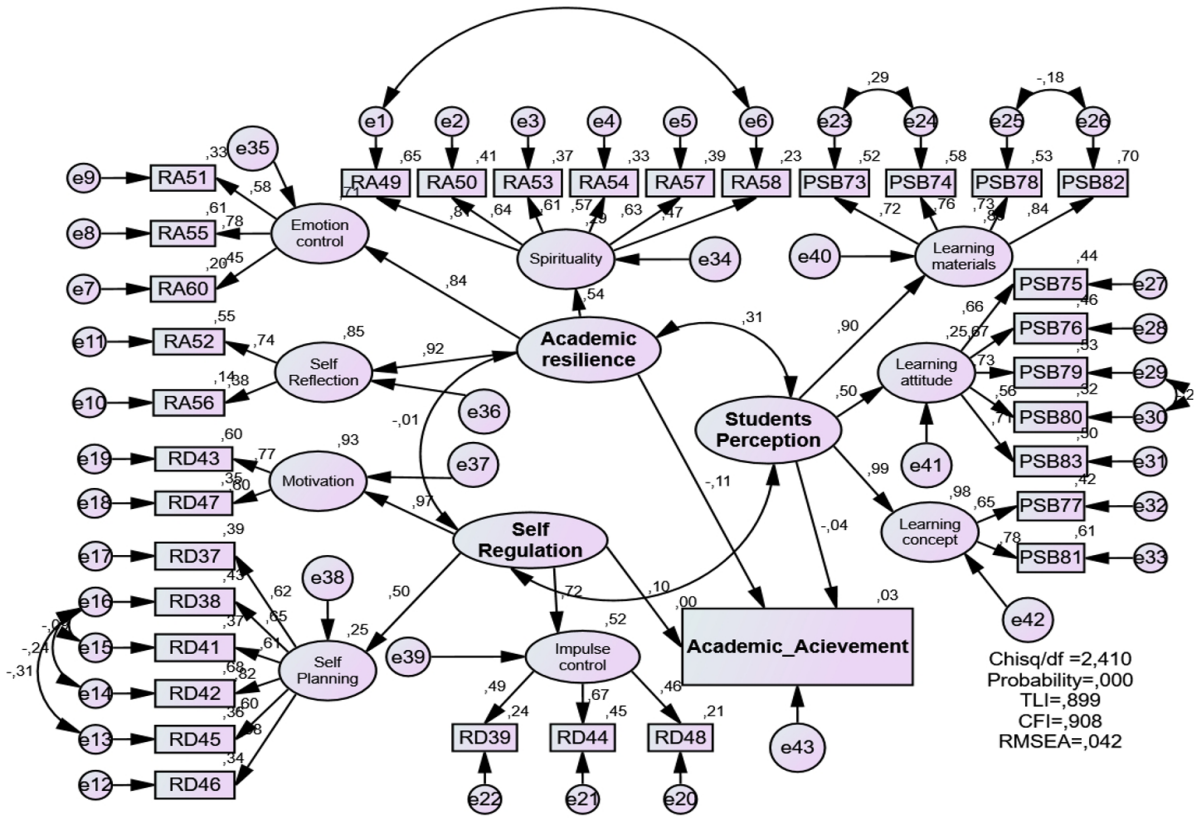

Figure 5: the CFA results are pooled, and the output that displays every fitness index attained

Convergent Validity and Composite Reliability Evaluation

Table 3 indicates that students' perceptions of chemistry, academic resilience, and self-regulation have AVE scores of 0.84, 0.86, and 0.88, respectively (with a minimum value of 0.5), indicating that the assessment of convergent validity was effective (Ahmad et al., 2016). In the meantime, students' views of chemistry, academic resilience, and self-regulation all had CR values of 0.89, 0.91, and 0.94, respectively (with at least 0.6 as the minimum value) (Ahmad et al., 2016). The CR value for this variable is known to show that CR has been attained.

Construct	Factor loading	CR	AVE
Academic resilience	6.59	0.89	0.84
Spirituality	3.67	0.90	0.97
Emotion control	1.8	0.89	0.94
Self-reflection	1.12	0.85	0.87
Self-regulation	6.77	0.91	0.86
Self-planning	3.79	0.93	0.98
Academic motivation	1.37	0.90	0.93
Impulse control	1.61	0.89	0.93
Student's perception	7.81	0.94	0.88
Learning materials	3.09	0.95	0.98
Learning attitude	3.29	0.93	0.98
Learning concept	1.43	0.94	0.96

Table 3: Presents composite reliability (CR) and average variance extracted (AVE) values

Evaluation of the Discriminant Validity of Constructs and Normality

The discriminant validity results are shown in Table 4. Discriminant validity was employed to gauge how distinct a construct is from other constructs, according to (Hair et al., 2010). Table 4 results indicate that every construct in the study met the criteria for discriminant validity. According to Mohamad et al. (2016) Malaysia using self-administered questionnaires among Malay youths. A total of 431 youths were involved in this study, comprising 204 males and 227 females. Structural Equation Modelling (SEM, there are greater values for the square root of the average variance derived from each construct (diagonal values in bold) than for the correlations between each construct. If there are no redundant construct problems, a correlation of less than 0.85 is valid (Awang et al., 2015).

Variable	Academic resilience	Self-regulation	Student's perception
Academic resilience	**0.84**		
Self-regulation	-0.02	**0.86**	
Student's perception	0.31	-0.01	**0.88**

Table 4: A summary of each construct's discriminant validity index

The data was examined for normalcy using the skewness and kurtosis criteria for normality testing. To show that the data is regularly distributed, the skewness score should be between -3.0 and 3.0 (Kline, 2016). Furthermore, to presume that multivariate normality is attained, the multivariate kurtosis value must be less than 50.0 (Mohamad et al., 2016). All of the variables' skewness values fall within the permitted range. Consequently, the data is considered normal.

Testing the Hypothesis

The regression coefficients between the constructs and the outcomes indicated in Tables 5 and 6 are depicted in Figure 4. The outcomes suggest a substantial correlation ($P < 0.05$) between students' academic achievement in chemistry and their academic resistance towards the subject. Students' academic progress in learning chemistry is, therefore, influenced by their academic resilience towards the subject, which is comprised of the sub-dimensions of spirituality, emotional regulation, and self-reflection. In addition, the study's findings demonstrate that chemistry students' academic success in the subject is significantly influenced by their ability to self-regulate, which encompasses motivation, impulse control, and self-planning ($P < 0.05$). Lastly, the findings indicate no significant relationship between student perceptions of the learning materials, learning attitudes, and learning concepts and academic achievement in chemistry ($P > 0.05$). Consequently, one hypothesis is not statistically supported at the 5% significance level, whereas two are.

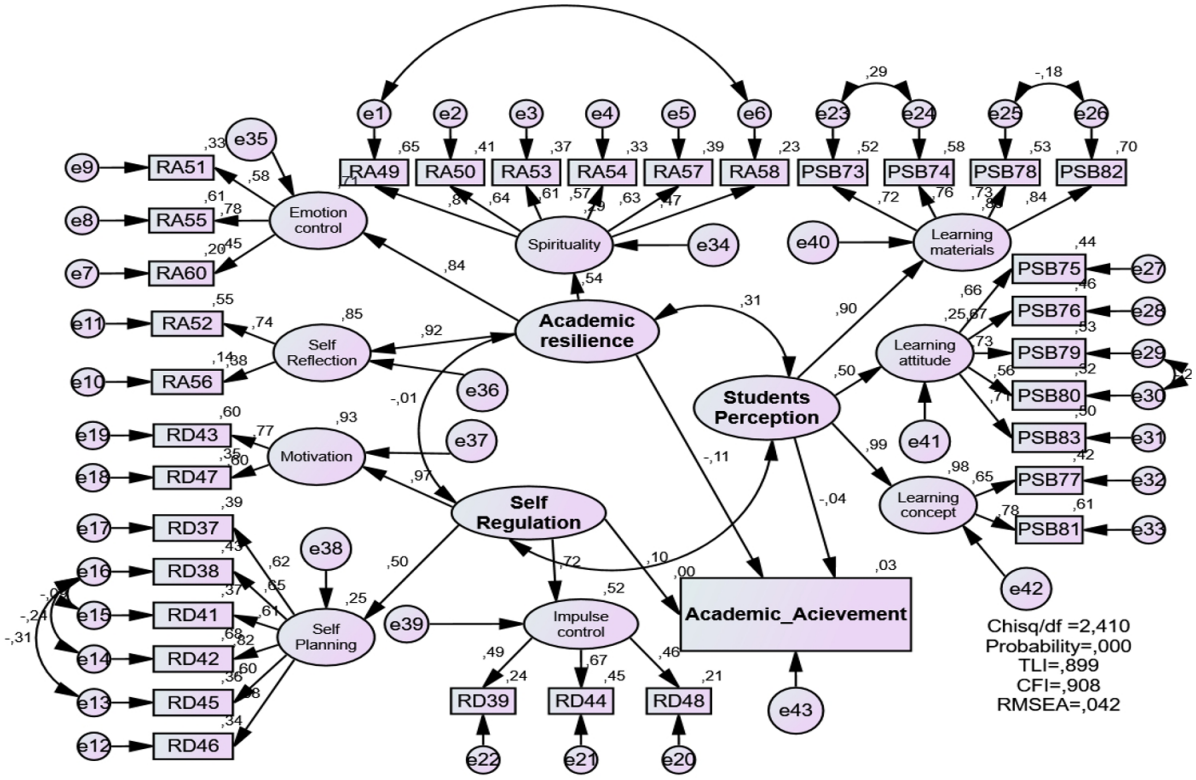

Figure 5: Study constructs' standardized regression path coefficients

Regression Path	Estimate	S. E	C.R	P	Result
Academic achievement <--- Academic resilience (H_1)	-5.40	2.26	-2.39	0.02	Significant
Academic achievement <--- Self-regulation (H_2)	8.83	3.86	2.29	0.02	Significant
Academic achievement <--- Student's perception (H_3)	-1.84	1.56	-1.17	0.24	No Significant

Table 5: the correlation coefficient of the regression path between the construct and its importance

Hypothesis statement	Result on hypothesis
H_1: Academic achievement is significantly impacted by the academic resilience of learning chemistry.	Supported
H_2: Academic achievement is significantly impacted by the self-regulation of chemistry learning.	Supported
H_3: Academic achievement is significantly impacted by students' perceptions of their chemistry learning	No Supported

Table 6: the testing of hypotheses

DISCUSSION AND CONCLUSION

This study examined the impact of academic resilience, self-regulation, and student perception on high school students' cognitive achievement in chemistry. The findings of our study showed that the average cognitive achievement of students in chemistry was 63.48, which is considered moderate. Studies have reported similar moderate achievement in chemistry, suggesting that instructional strategies play an important role in shaping students' cognitive outcomes (Nwafor et al., 2024). Furthermore, studies have shown that cognitive factors such as prior knowledge, reasoning ability, and memory capacity significantly influence chemistry achievement, with students at higher cognitive operational levels performing better in conceptual and computational tasks (Oloyede, 2012; Van Hootegem et al., 2023). These findings emphasize the need for innovative instructional approaches, such as inquiry-based strategies or cognitive modeling, to enhance students' reasoning abilities and improve their overall cognitive performance in chemistry (Aziz and Ahmed, 2018). Therefore, while moderate achievement levels reflect a basic understanding of chemical concepts, they also highlight the need for targeted interventions to foster higher-order cognitive skills and improve learning outcomes.

In addition, academic resilience, self-regulation, and students' perceptions of chemistry were all at a moderate level on average. Judging from the average value, academic resilience scored higher than self-regulation or students' perceptions. Spirituality can act as a buffer and help people cope with difficult situations. People who believe in themselves often have strong coping mechanisms to handle stress better (Imron et al., 2023). Emotional regulation is also important to academic resilience, helping them manage stress (Chye et al., 2024). Self-reflection also helps resilience because it allows students to assess their learning experiences, identify their strengths, and create

strategies for improvement (Phan et al., 2021). Self-regulation relies more on individual cognitive control and discipline, which may not always be enough to overcome academic difficulties. This contrasts with academic resilience, which is influenced by deep personal and external support systems (de la Fuente et al., 2018). In addition, students' perceptions of chemistry lessons are often influenced by things that come from outside, such as teaching styles and assessment methods. This can lead to lower overall self-assessments than resilience (Biswas and Bhowmick, 2024).

The first hypothesis (H_1) suggests that students' academic resilience in chemistry significantly affects their academic achievement in chemistry exams, even though the correlation is negative. In this context, a negative correlation means that the higher students' academic resilience in chemistry, the lower their academic achievement in chemistry exams, or vice versa. This suggests that high levels of negative academic resilience in this study may lead to low academic achievement. Nakhostin-Khayyat et al. (2024) examined the connection between self-regulation, cognitive flexibility, and resilience. They discovered that resilience promotes emotional health but does not always lead to improved cognitive performance. In addition, the study found that although resilience can reduce the impact of socioeconomic disadvantage, it does not always result in increased high cognitive scores (Rakesh et al., 2024). In contrast to the results of the study, it was found that there is a relationship between student achievement and academic resilience, and this relationship is positive (Amzil, 2022; Almulla, 2024). Strong interpersonal and social affective skills are associated with academic resilience (Hwang and Shin, 2018). On the other hand, the self-reflection dimension has the greatest influence on academic resilience, indicating how important self-reflection is to students' ability to overcome academic challenges. Students who actively engage in self-reflection develop better learning strategies and adaptability, which enhances academic resilience and well-being (Hammad Al-Rashidi and Aberash, 2024) both self-evaluation (SE).

The second hypothesis (H2) posits that students' self-regulation considerably impacts their cognitive achievement on chemistry tests. In line with that, self-regulation positively and significantly correlates with cognitive achievement (Yasmintya et al., 2024). Students who use self-regulation strategies often succeed in future planning and self-efficacy because it allows them to manage their emotions and have better educational performance (Sahranavard et al., 2018). Research shows that self-regulation strongly predicts academic achievement (Hindradjat et al., 2022). Self-regulated learning can explain 26.7% of the variation in learning achievement (Syahniar, 2018). The same thing is stated by Kashif and Shahid (2021), namely that self-regulation significantly influences academic success. Higher academic achievement is shown by students who show high levels of self-regulation. In addition, it offers evidence of the moderating role of academic achievement in the relationship between academic achievement and self-regulated learning (Xiao et al., 2019). The findings show a statistically significant positive correlation between academic achievement and SRL. Thus, academic achievement increases with increasing levels of SRL, while academic achievement decreases with decreasing levels of SRL (Rosário et al., 2008). Students who have self-regulation are responsible for their actions and can exercise self-control and self-improvement (Sumarni et al., 2020).

Motivation drives students to maintain learning efforts and engage in goal-directed behaviors. Therefore, the motivational dimension has the greatest influence on self-regulation. More motivated students show better self-regulation skills, especially in psychology classes emphasizing self-directed learning and critical thinking (Avecilla et al., 2023). In addition, the effect of self-regulation in virtual reality learning was investigated, and it was found that motivation plays a significant role in determining how effectively students manage their learning strategies and stay engaged in complex tasks (Sindu and Kertiasih, 2024). Furthermore, Martha et al. (2023) online learning has become commonplace in higher education. Various factors influence the success of online learning. Factors such as low self-regulation and co-regulation of learning skills can affect student engagement and motivation in online learning activities. Therefore, it is essential to provide external support in the online learning process. Pedagogical agents are one solution to increasing self-regulation and co-regulation learning in online learning environments. This study aims to determine the effect of integrating metacognitive and motivation scaffolding support provided through pedagogical agents on self-regulation and co-regulation learning skills. This study uses a mixed-method explanatory sequential approach. A quasi-experimental method of the nonequivalent type (pretest and posttest showed that incorporating metacognitive and motivational-based scaffolding into an online learning environment significantly improved students' self-regulation ability. It also strengthened the relationship between motivation and self-regulated learning.

According to the third hypothesis (H3) findings, students' perceptions of chemistry have an insignificant negative effect on academic achievement in studying chemistry. Based on identical research findings, Ahmad et al. (2017) concluded that there was no significant difference between the perspectives of male and female students regarding the teaching and learning process. Similar research by Dewi et al. (2023) found that students' perceptions of the use of online chemistry learning were negative. A person will be inspired to perform better in a subject if they understand it well. Perception is the capacity to perceive, feel, analyze, and evaluate one's surroundings. In addition to perception, various elements can affect academic achievement because they are components of learning activities. The element of learning interest can impact academic achievement because motivated students perform better academically (Salifu and Bakari, 2022).

All predictor variables studied in this review can have positive and negative effects, both directly and indirectly, on students' academic achievement. In this study, academic resilience significantly negatively influenced academic achievement and significantly positively influenced self-regulation. Finally, students' positive and negative perceptions did not affect their academic achievement. This suggests that poor academic achievement may arise from high levels of negative academic resilience in their studies. In contrast, strong

academic achievement may arise from high levels of positive self-regulation in their studies. Finally, students' negative but negligible perceptions were insignificant to good or low academic achievement. Therefore, these percentages imply that more factors influence students' academic achievement in chemistry. Therefore, it is highly recommended that this issue be investigated further by considering additional factors.

Limitations and Implications

There are various limitations to this study. Firstly, this survey only included 14 public schools; it did not include all Indonesian schools. Second, because of the study's cross-sectional design, no causal relationship between students' perception of chemistry learning and academic achievement can be established; only associations can be detected. The results revealed no substantial relationship between students' perception of chemistry learning and cognitive achievement. This shows that students' perception of learning chemistry may be more concerned with comprehending, assessing, and evaluating the subject matter than directly influencing their achievement.

Other elements, such as self-regulation and academic resilience, are likely to impact cognitive achievement. Future research should investigate these elements and their possible influence on students' cognitive achievement. Longitudinal or experimental research may also provide more information on the causal mechanisms that underpin these relationships.

This variable and others identical to it can be used to test alternative models in future research. Additionally, while this study only employs a quantitative methodology, more qualitative approaches should be added to broaden the conversation. Therefore, limitations in this study may limit the generalizability of our findings, making the results less applicable to a wider audience. However, this issue can be addressed by repeating this study in the future, perhaps with improvements to address these limitations.

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APPENDIX

APPENDIX 1: REPLY DOCUMENT

	Reviewer	Author Revision
Introduction/ Theoretical Framework	The authors should focus exclusively on explaining academic resilience and exclude from this paragraph the discussion on the general concept. Also, they affirm that there is no background on resilience in chemistry, yet they also state that a plethora of studies has focused on resilience in other subjects. As a consequence, the authors should present at least some of the said papers: what did other authors find in their studies in other subjects? What were the major conclusions from said works? A similar approach should be taken for the other variables (predictors) in the model, with a higher focus on their direct relationship with the academic/educational environment and more details regarding previous studies. Hence, I would suggest removing the general explanations (definitions, meaning of the studied variables in the overall life) and only providing information directly related to the study. An additional suggestion after reviewing the results section: the authors should put their efforts into presenting the theory and previous research on the sub-dimensions of each studied variable: so, not only presenting the overall relationship academic achievement-resilience, academic achievement-self-regulation, etc., but also explaining and presenting previous work on impulse control, self-planning,… spirituality, emotion control,…etc. The reader needs to understand what the theoretical background is that shows that these dimensions belong to their corresponding latent variable. This way, it is then easy to navigate through the results.	• The author has added an explanation of academic resilience in chemistry, self-regulation in chemistry. • Then the author has added an explanation of the dimensions related to the variables of academic resilience (spirituality, emotional regulation and self-reflection), self-regulation (self-planning, impulse control and motivation) and the perception of chemistry students (learning materials, learning attitudes and learning concepts). • Furthermore, the author adds the relationship between these dimensions to each variable and why choose these dimensions.
Methods	Please provide descriptive information on the sample in “sample” section rather than in results, since it helps understanding the segment of population considered in the study. In the results section, you should only include the results that directly respond to your hypotheses. How were schools and students recruited? Which sampling technique was used? Were there exclusion/inclusion criteria? Is the study supported by ethical approval? Please provide information in the sample section. Regarding the instrument, I believe the study would benefit from providing more (and better) information: for example, from the current text I understand that Part A proposes items related to the predictors (resilience, perceptions, etc.) and the outcome variable (achievement), with 11 items per each. Where do these items come from? How were they selected? From previous published works? To add to confusion, it seems that part c also includes questionnaires on the same variables – why taking data on the same variables twice? Also, if the questionnaires used were adjusted from previous works (as it is suggested), what kind of adaptation has been done? Were they translated into the students’ language? Regarding part B, what is the purpose of questions on structure-related chemistry? Which variable/s is this questionnaire measuring? (also considering that all variables in the study seem to be already assessed in parts a and c). Please be as specific as you can, since this is an essential part of your study if you wish to demonstrate that your results are valid and sound – and also for repeatability purposes. Moreover, since the questionnaires present structures with sub-dimensions (as presented in the results section, for example, academic resilience is composed by spirituality, emotional control, etc.), the authors should also explain how the structure of the questionnaire is (for instance, items per sub-dimension? Sample question/s?). Beyond the needed information I mentioned above, a table clearly summarizing the questionnaire would be helpful. The table is just a suggestion, and the authors can add it or not, but the above-mentioned extra information must be added. A limitation to be considered is that, since the study is cross-sectional, the cause-effect relationship between predictors and outcome variable cannot be confirmed – only pure association. This is quite a common approach in research with SEM or mediation analysis, nonetheless, the authors should still point it out.	• The author has changed the position of the research results to the research sample and added some additional information so that readers can understand the purpose of this research. • Improvements have been made to the instrument so that readers can understand this research well • I have also added input from reviewers regarding making the instrument table more detailed and structured • I have made improvements to the limitations of this research according to the reviewer’s instructions

	Reviewer	Author Revision
Overall Aspects	The authors should review and adjust the format of the paper based on general formatting rules (for instance, when authors are cited directly in the text, the brackets are not needed) and based on the journal's guidelines. Also, it is uncommon to use sentences such as "the author has found/the author has come across…/we have done this or that" etc. Scientific papers do not use this language, but they keep an "external view". For example, if the author has not found any literature background on a topic, they should say (example from the resilience section) "despite a plethora of studies have focused on resilience in education, there exists a literature gap in the area of chemistry". This is just an example, the authors are free to make changes as they consider fitting, however, they need to review this aspect somehow in order to increase the "scientific shape" of the paper Additionally, I recommend that the authors revise the use of English throughout the paper – in some sections, such as, at the beginning of "Theoretical Framework", some sentences are hard to follow, limiting the fluidity of the reading and its understanding	• The author has revised and adjusted the format and writing style of the paper to align with general academic standards and journal guidelines. Here is a description of what this means: • The author has revised the scientific writing style according to the reviewer's suggestions. • Clarity and Readability: the author has revised the initial section of the Theoretical Framework) to make it look better • The author has revised the English to improve readability and can be understood well