Research Report **Somnoactive**

As poor sleep is a major problem in today's fast-paced modern society and among students, team Somnoactive intended to promote healthier sleep and to improve the overall wellbeing. Therefore, we created and easy-to-implement daily routine which combines a short exercise with scientifically proven measures to enhance student's sleep quality. Furthermore, we investigated how incentives for active reflection and feedback on already achieved progresses impacts the motivation to follow the routine. To get an additional insight into cross-cultural aspects, we not only conducted the study at TUM but also at Kwame Nkrumah University of Science and Technology in Kumasi/Ghana.

Team   Florian Brandl
            Vedant Gupta
            Johann Ioannou-Nikolaides
            Samira Körner
            Vivian Meier
            Luisa Metten
            David Schuster
            Lena Straßer

Tutors   Genoveva Müller
            Elisa Rodepeter

Supervisors Prof. Dr. Philipp Reiss
            Prof. Dr. Manuel Spitschan

Somnoactive

Preface by the Supervisors

Prof. Dr. Philipp Reiss and Prof. Dr. Manuel Spitschan

Poor sleep is a major problem in today's fast-paced, 24-hour society, reducing productivity, affecting social relationships and causing mental and physical health problems. The goal of the Somnoactive team was to create an effective routine that promotes regular and improved sleep, and thus overall wellbeing, and that can be easily integrated into daily life.

To achieve this goal, the team implemented a study with university students, accompanied by interventions of short, daily exercise routines, a sleep diary, and suggestions for improving sleep hygiene while measuring the sleep-wake cycle using wrist-worn actiwatches. With their study, they raised awareness for this important topic and found that the multi-component intervention has a significant positive impact on subjects suffering from insomnia. The team also conducted a second study in collaboration with Kwame Nkrumah University of Science and Technology (KNUST) in Ghana, a flagship partner university of the Technical University of Munich, investigating cultural differences.

As supervisors, we were thoroughly impressed by the high level of motivation within the team and the self-directed management of the entire project – from concept to analysis. As the topic was new to most of the Somnoactive team, their accomplishments are all the more impressive and noteworthy.

Supervisor insights
Prof. Dr. Philipp Reiss

It was an insightful experience to see how the team developed their idea and realized it within a very short time besides their studies. The team showed great commitment by bringing together expertise from various backgrounds and produced a novel method to investigate and improve sleep hygiene – a topic that is highly relevant to us all.

What is your research interest or motivation for science?
As a professor of lunar and planetary exploration, my goal is to develop and expand our knowledge and capabilities in space science and exploration, with a focus on volatiles and resources on planetary bodies. Besides research, my priority is the education of our students, providing them with the best possible opportunities and supervision to acquire and develop their skills and prepare for a future career.

What special experience from your studies/career would you like to share with the scholars?
During my studies I was always actively seeking practical experience by participating in various projects, internships, and student groups. In a small team, we even developed and launched a microgravity experiment on a sounding rocket, which was an outstanding learning experience I still treasure today. The university environment offers a variety of such opportunities, including TUMJA, and I encourage our students to explore these and go beyond the common boundaries of the study program.

Supervisor insights
Prof. Dr. Manuel Spitschan

It was great to see the team flourish and take full ownership of the project. The topic – using a simple and scalable intervention to empower people to optimize their sleep hygiene – is right at the core of my research group's interest.

**What was your best TUMJA moment?**
Seeing the team reach out to potential partners at KNUST in Ghana, a flagship partner university of TUM was great. The team demonstrated the feasibility of this novel arm of their project and acquired further funding for it. As a circadian neuroscientist and sleep researcher, the 'global' approach to research is key, and seeing the Somnoactive team have this view toward the horizon, and leaping towards it, was invigorating.

What does mentoring the team mean for your own research?
Mentoring the Somnoactive team brought home the value of an interdisciplinary team approaching a joint problem of high importance not only to science but also to society. As a scientist, professor research group leader, it can sometimes be easy to work only within one's own scientific silo. Seeing a student team take an interdisciplinary approach was exciting and extremely rewarding. ◼

Did you sleep well last night? Most likely not!

Improving students' sleep in Ghana and Germany

As Prof. Atinuke Adebanji opens the door to her office, she wears a bright smile and a patterned dress of vivid orange and purple colors. The dress is self-designed; she learned how to sew when she was younger and still uses that skill to design her own clothes nowadays. Five of us are visiting Kumasi for one week and asked her for an interview. Prof. Adebanji is a Professor at the Department of Statistics & Actuarial Science at the Kwame Nkrumah University of Science and Technology (KNUST) in Kumasi, Ghana, where she holds her lectures and coordinates the Laboratory for Interdisciplinary Statistical Analysis (LISA). Besides her work as a professor, she is a founding member of WiSTEMGh (Women in STEM, Ghana). This initiative offers mentoring workshops and summer schools to senior high school girls and young women, to inspire and support them to become senior scientists and technologists. Prof. Adebanji had her battles to fight, being a woman in a male-dominated field. Growing up in Nigeria, she knew from a young age that she had two passions – books and teaching, but the journey to research

would take some twists and turns. Having left secular work in accounting to be a stay-at-home mother for about 7 years, she entered academia in 2003 as an Assistant lecturer at the Department of Mathematics, University of Agriculture, Abeokuta, Nigeria. In 2009, she was the acting head of the newly created department of Statistics when she became aware that KNUST was looking for a lecturer to introduce a Statistics program at the university, so she left her former university and moved to Kumasi to focus on her academic career – even though she was the only woman in the Maths department at that time.

Fourteen years later, she is hosting us at her university for our sleep-related study. The topic of 'sleep' is becoming more and more famous and awareness about its importance for physical and mental health is increasing. Still, the student population tends to suffer strongly from insomnia, bad sleep quality and low sleep duration. The number of young adults with diagnosed sleeping disorders is rising. Many students do not get the recommended 7-9 hours of sleep per night, especially not during exam periods. This can lead to several mental and physical problems and a reduction in academic performance. Although research on the topic has increased significantly over the last two decades, effective solutions to this problem still need to be found. We aimed to provide a low-threshold routine that improves the participants' sleep efficiently without taking up too much time every day or changing the students' day-to-day life too radically.

To do that, we designed a 30-day routine. During the intervention, the participants receive a video every morning, which includes an easy and short workout to stimulate the cardiovascular system and a scientifically proven suggestion on healthy sleep hygiene practices. We previously carried out the study in Munich and are now looking for participants at KNUST. After both studies, we would like to compare sleep habits in Ghana and Germany, keeping in mind the different cultural and climatic conditions.

We are not the first research group of TUM that is visiting KNUST. The strategic partnership between the two universities started in 2018, after several collaborative projects. Prof. Adebanji herself isn't very involved in the partnership, but started working with professors at TUM, mainly Prof. Müller from the Maths Department and Prof. Tellier in Genetics, about two years ago. A few of her graduate students participated in the TUM.Africa Talent program, an exchange program for doctoral candidates, and, therefore, stayed in Munich for three months. At the closing event of this program, two of us first met Emmanuel Owireda, a participant of TUM.Africa and Assistant Lecturer at KNUST. He later helped to organize and conduct the study in Kumasi and initiated the first contact between Prof. Adebanji and us. When she first heard of the project, she was happy and excited to host us in Kumasi, especially because she hoped to encourage contact between us and KNUST students. She envisioned a gathering of both groups, to give the KNUST students the opportunity to ask questions about life and studies in Germany. Unfortunately, such a gathering did not take place during the week we stayed in Kumasi due to a tight schedule. Hopefully, future teams can take this opportunity.

We did, however, visit several lectures to advertise our project and to look for participants for the study. In the end, we were able to enlist 54 students, the same number of participants as we had in Munich. All students were introduced to the topic and the study procedure and were equipped with a sleep tracker. The sleep tracker is an essential part of the study and measures the activity of the person who wears it throughout the night. With this information, it is possible to determine the participant's pattern of sleep phases and draw conclusions about changes.

After the interview, we present some gifts from Munich, a Beer Making Kit and gingerbread hearts, to thank Prof. Adebanji, Emmanuel and all the other responsible people for their help and hospitality throughout the past week. We definitely enjoyed our stay in Kumasi and encourage other teams to organize a similar exchange themselves. Hopefully, we were able to strengthen the bond between TUM and KNUST and help students in both universities to sleep better in the future.

Our Top Ten sleep facts:

■ Start your day outdoors! Exposure to natural light can assist in waking up and prevent afternoon crashes.

■ Create a relaxing bedtime routine tailored to your preferences, like reading or listening to soothing music, and limit screen time to avoid disruptive blue light.

■ Incorporate a cold shower into your morning routine to feel more energized throughout the morning.

■ Limit caffeine intake within the first hour or two of waking up and avoid it before bedtime to ensure a restful night's sleep.

■ If you're having trouble falling asleep, get out of bed and do a calming activity until you feel drowsy rather than staying awake in bed.

■ Exercise in the morning to enhance alertness and synchronize your body's internal clock.

■ Experiencing orgasm, no matter how it's achieved, can help with falling asleep.

■ Determine your chronotype (morning lark, hummingbird or night owl) to understand your natural sleep tendencies and, if possible, adjust your schedule accordingly.

■ Resist the urge to hit snooze to avoid disrupting your sleep cycle.

■ If you need a nap, aim for a short duration of 10-20 minutes to prevent disrupting your nighttime sleep

The Impact of Self-reflection and Feedback in an Intervention on Sleep Habit Improvement

The importance of sleep for health and well-being is well known, yet third of all adults in the US report getting less than the recommended amount of sleep. Here, we investigate the impact of feedback and incentives for active self-reflection on drop-out rates in a 30-day intervention for sleep habit improvement. Furthermore, the impact of the intervention on the participant's sleep routine and quality is studied. After the study an overall reduction of BIS scores is observed for participants completing the study. A significant improvement is noted in participants identified as "insomniacs" at the beginning of the study, providing some evidence that the multi-component intervention including sleep education, physical exercise, and relaxation techniques, has a positive impact on subjects suffering from insomnia. Study groups receiving incentives for active reflection by filling out a sleep diary, or additionally receiving feedback on sleep improvements, showed a higher motivation for study continuation and therefore a lower drop-out rate.

Background:
The importance of sleep for health and well-being is well known to the general public. However, poor sleep and insomnia remain prevalent issues worldwide. A reason for this prevalence could be that adhering to routines aimed at treating symptoms is difficult. Therefore, we studied the effect of feedback and incentives for self-reflection on the completion rate of a 30-day multi-component intervention, including sleep education, physical exercise, and relaxation techniques. Also, the effect of the intervention on the participant's insomnia and sleep hygiene knowledge was studied. A comparison between participants in Germany and Ghana was made.

Methods:
Healthy students (*n* = 56, age range 18-30) were randomized to three study groups, one watching only videos during the intervention, one watching videos and filling out a daily questionnaire, and a third one watching videos, filling out a daily questionnaire, and getting weekly individual feedback. The Bergen Insomnia Scale was used to assess insomnia symptoms before and after the study, while a Sleep Hygiene Knowledge questionnaire based on sleep myths and evidence-based sleep hygiene recommendations was used to assess improvement of knowledge before and after the study.

Results:
After the study an overall reduction of BIS scores is observed for participants completing the study. A significant improvement (5 points compared to pre-intervention) is noted in participants identified as "insomniacs" at the beginning of the study, providing some evidence that the multi-component intervention including sleep education, physical exercise, and relaxation techniques, has a positive impact on subjects suffering from insomnia. Study groups receiving incentives for active reflection by filling out a sleep diary, or additionally receiving feedback on sleep improvements, showed a higher motivation for study continuation and therefore a lower drop-out rate.

1 Introduction

Understanding of the importance of sleep for well-being, i.e., physical and mental health, as well as cognitive and physical capabilities, is well established [1, 2, 3]. Although the significance of sleep is widely recognized and acknowledged by the general public, it is often disregarded that maintaining a consistent sleep schedule can help in regulating the circadian rhythm and enhancing overall sleep quality [4]. Acting as an internal clock, the circadian rhythm regulates hormone production and the body's metabolism, as well as people's sleep [5]. A disturbance or lack of sleep is therefore associated with a disruption of the internal clock, potentially leading to adverse health effects such as obesity [6], hormonal imbalances [7], mental health problems [8], and learning and memory difficulties [9] (see e.g. [10] for a review).

Poor and inconsistent sleep is not a niche problem but affects large swathes of society, with one-third of Americans reporting getting less than the recommended amount of sleep [11], one out of ten Europeans suffering from chronic insomnia [12] and also 7.5% of

adults in low- and middle-income countries reporting sleep problems [13]. More alarmingly, the prevalence is increasing [14], highlighting the importance of addressing this issue on a societal level. Within 20 years, the prevalence of sleep problems in low-income countries is expected to almost double, from 150 million in 2010 to 260 million in 2030 [15].

There are major social reasons for sleep deprivation and sleeping patterns that diverge from the 24-hour light-dark cycle. The phenomenon of shorter sleep during work weeks has been coined as "social jetlag," and with the rising availability of instant media and entertainment, this often leads to strong variations and disruptions in sleep patterns resulting in reduced sleep quality.

To tackle the adverse health and other negative effects [16] of poor and/or insufficient sleep and promote better sleeping quality, a simple but effective intervention, that can be used on a large scale without requiring any advanced tools, is desirable. Albakri, Drotos, and Meertens [17] reviewed existing intervention studies and classified them into eleven broad categories, namely: sleep education, behavioral change methods aimed at promoting awareness and active control of routines and stimuli, relaxation techniques, physical exercise, mind-body exercise that combine meditation with physical exercise, aromatherapy and or massage, environmental, psychotherapy, later school times, multicomponent, and others. The effectiveness of these interventions varies strongly among studies, with Lie Åslund et al. [18] reviewing six studies among school-age children and adolescents and finding an increase in total sleep time (TST) and sleep onset latency (SOL) in the intervention group during the studies. The positive effect on SOL remained in follow-up studies 4-8 weeks later. A review of interventions that included education on sleep hygiene behavior among undergraduate or graduate college students (18 years or older) found three studies reporting no significant difference on sleep quality ($P > 0.05$) and only one study reporting significant improvements ($P = 0.017$). Although the sample size of reviews is small, Albakri, Drotos, and Meertens [17] found promising improvements in TST and sleep quality for physical exercise interventions and some small positive impacts on sleep duration for sleep education interventions.

For a broad application in the general public, a multi-component intervention, including sleep education, physical exercise, and relaxation techniques, hold up to the aim of being simple in their implementation and requiring no additional tools. It should therefore serve as a good basis for a sleep improvement protocol.

Even though studies with similar methodologies reach different conclusions and overall impact appears low, there were no reviews indicating adverse effects. This indicates that the reason for no significant improvement in sleep duration and quality in certain studies might have been a consequence of how motivated and prepared the participants were to change their sleep habits, how relevant and important sleep was to them, and how the intervention was delivered and designed [19].

Therefore, an important aspect of a successful intervention is to make the program engaging – like Duolingo for language learning, for example.

Most importantly, an intervention should keep participants' intrinsic motivation high over a long time. To build a long-lasting habit, it takes around 66 days of repetition [20], while a lack of motivation and the appearance of boredom are major reasons why people stop routines beneficial to their health.

One of our aims is therefore to study how intrinsic motivation can affect the adherence to a sleep improvement routine. The developed 30-day program, designed around proven sleep hygiene measures to help students establish a better sleep routine, is outlined in detail in subsection 3.1. The students participating in our study all followed a 30-day program, whereby one group was encouraged to actively reflect on their sleep by filling out a daily questionnaire, the second group, on top of that, got weekly feedback on their progress, while a control group only followed the 30-day program without further reflection incentives or feedback.

2 Goals

The primary objective of the study was to investigate the conditions under which students maintain their motivation to participate in a 30-day intervention on sleep and physical activity. This research interest led to the formulation of the following research question:

Research Question: How do feedback and incentives for active reflection influence the motivation of participants to stay engaged and committed to a 30-day routine to improve their sleep quality?

Based on the research question, a hypothesis was developed:
Hypothesis: Participants who receive specific feedback on changes regarding their sleep during the 30-day program will be more motivated to continue with the intervention. Furthermore, we expect that existing incentives to reflect on sleeping habits in the form of filling out a questionnaire regularly help in actively noticing positive changes, thereby also increasing the motivation to stay committed.

Apart from this overall research objective, the study and especially the developed routine program (also aimed to reduce the time it takes the participants to fall asleep) decrease the number of times they wake up during the night, increase the feeling of restfulness in the morning, and reduce tiredness during the day.

To draw conclusions about possible intercultural differences, the study was also conducted at Kwame Nkrumah University of Science and Technology in Ghana, a partner university of Technical University of Munich.

3 Methods

In the following, a detailed description will be provided of how the above-mentioned research objectives were methodically investigated and processed.

3.1 Development of a 30-Day Routine Program

The 30-day routine program, which formed the basis of the study, was developed conscientiously and based on scientifically proven measures by the project group. It consisted of 30 videos with a length of 7 minutes each, in which practical exercises for physical activity and information how to improve one's sleep hygiene were presented. The videos were produced by two members of the project group, assisted by an experienced videographer.

3.2 Surveys and Questionnaires

For the study, a total of 4 different questionnaires were developed, as seen in the following.

- **Initial survey (1x, pre-intervention):** Prior to study start, participants were given an initial questionnaire. Besides organizational questions, the participants had to answer questions relating to sleep and tiredness using the Bergen Insomnia Scale (BIS). Furthermore, prior knowledge about sleep hygiene was investigated by various questions. Both sections will be explained in further detail below.

- **Questionnaire about sleep in the previous night (daily throughout the study):** During the 30-day program, the participants were asked to answer a few questions about their sleep during the previous night each day after watching the exercise video. This questionnaire included, for example, the time it took one to fall asleep or the frequency of waking up during the night.

- **Survey about motivation (weekly throughout the study):** In a weekly rhythm, participants were asked about their general motivation to maintain the program or routine.

- **Final survey (1x, post-intervention):** In addition to general organizational questions, the participants should, as in the initial survey, answer questions relating to sleep and tiredness using the Bergen Insomnia Scale (BIS). Furthermore, a list of all sleep facts that were provided to the participants during the study was presented and the participants had to answer whether a sleep hygiene measure was new/surprising to them; if they had continued any of them so far; if they planned to continue one in the future; and if they were able to incorporate the sleep hygiene measure into their day-to-day life. Finally, the sleep hygiene knowledge questionnaire was given again, to check whether their knowledge level might have changed.

The Bergen Insomnia Scale (BIS) questionnaire [21], that was used in the initial and final survey, contains six questions (see Table 1). It is based on the Diagnostic and Statistical Manual of Mental Disorders [22], and aims to asses insomnia, with the first three questions being on the ability to fall asleep, stay asleep, and sleep enough, while the second three questions asses tiredness and sleep satisfaction. In the BIS questionnaire, the participants were asked to

answer on a scale from 1 to 7, whereby 0 meant no days during a week, while 7 meant every day during a week.

In addition to the BIS, participants were also asked to fill out a questionnaire on sleep hygiene knowledge in the initial and the final surveys (see Tables 2 and 3). Half of the participants were given the statements in Table 2, while the other half were given the statements in Table 3. The groups were randomly selected without regard to which study group the participants belonged.

The participants were asked to rate the statements on a scale from 1 to 7. Whereas for the BIS an answer of 0 meant no days and 7 every day during a week, for the sleep hygiene questionnaire, the scale from 1 to 7 measured their agreement with the given statements, whereby 1 meant *Strongly Disagree*, 2 *Disagree*, 3 *More or Less Disagree*, 4 *Unsure*, 5 *More or Less Agree*, 6 *Agree*,

Question	Number of days per week
During the past month, how many days a week has it taken you more than 30 minutes to fall asleep after the light was switched off?	0 - 7 days
During the past month, how many days a week have you been awake for more than 30 minutes between periods of sleep?	0 - 7 days
During the past month, how many days a week have you awakened more than 30 minutes earlier than you wished without managing to fall asleep again?	0 - 7 days
During the past month, how many days a week have you felt that you have not had enough rest after waking up?	0 - 7 days
During the past month, how many days a week have you been so sleepy/tired that it has affected you at school/work or in your private life?	0 - 7 days
During the past month, how many days a week have you been dissatisfied with your sleep?	0 - 7 days

Table 1: The Bergen Insomnia Scale (BIS) questionnaire contains 6 questions on sleep patterns and perceived tiredness [21]

and 7 *Strongly Agree*. Half of the questions seen in Tables 2 and 3 were correct, meaning an answer of 7 is considered good, while the other half were incorrect, meaning 1 would be the correct answer.

3.3 Marketing and Recruiting
In order to draw attention to the study and recruit participants, different marketing strategies were implemented. On one hand, advertising posters were designed and placed at various locations around the TUM site. On the other, an Instagram channel served as a platform to raise awareness about the project and the possibility to register. In addition, promotional materials such as the poster and infographics were sent by e-mail to student councils and other TUM-affiliated organizations. The possibility of participating in the study was also raised by personal communication in the social environment of the project group. Participants were able to register for the study using a link via the portal "BayernCollab" whereby the registration period lasted about 5 weeks.

3.4 Participants and Study Groups
After the registration period, all registrants meeting the defined requirements were informed by E-mail about the further steps of the study. Applicants were disqualified if they met at least one of the following exclusion criteria:
- Not a student
- Pregnancy/Parenthood
- Major sleeping disorder
- Travelling to another time zone within the duration of the routine program
- Shiftwork

All participants were given an appointment to pick up a sleep tracker and sign further study documents. In total, 53 persons were officially introduced as study participants.

The participants were randomly assigned to three different study groups:
1. Group 1: Survey about motivation (weekly)
2. Group 2: Survey about motivation (weekly) + questions about sleep in the previous night (daily)
3. Group 3: Survey about motivation (weekly) + questions about sleep in the previous night (daily) + feedback on changes in sleep quality (weekly)

Number	Label	Statement	Source	Correctness
1	Consistent Sleep Schedule	Consistently waking up at the same time each day and going to sleep when the first signs of sleepiness emerge might contribute to better sleep hygiene.	[23]	True
2	Avoiding Caffeine	Avoiding caffeine within 8-10 hours of bedtime can improve sleep quality.	[24] [25]	False
3	Caffeine Intake	Caffeine intake in the morning after waking does not impact sleep quality.	[24] [25]	False
4	Light Exposure	Restricting exposure to bright lights, especially bright overhead lights, between 10 pm and 4 am might be associated with better sleep hygiene.	[26]	True
5	Short Naps Only	Limiting daytime naps to less than 90 minutes, or abstaining from napping, may be conducive to improved sleep quality.	[27] [28]	True
6	Pre-Bedtime Alertness	Expecting to feel highly alert approximately one hour before one's natural bed-time could be a characteristic of good sleep hygiene.	[29] [30]	False
7	Alcohol Consumption	The consumption of alcohol has no effect on sleep patterns.	[31]	False
8	Sleep Environment	Maintaining a cool sleeping environment may be a factor that improves sleep.	[31]	True
9	Sleep Needs	Sleep needs are individual and constant in adult humans.	[31]	False
10	Sleep Flexibility	Being able to fall asleep "anytime, anywhere" is a sign of a healthy sleep system.	[31]	False
11	Sleep Duration	Many adults need only 5 or fewer hours of sleep for general health.	[31]	False
12	Adaptability	Your brain and body can learn to function just as well with less sleep.	[31]	False

Table 2: Version 1 of the Sleep Hygiene Knowledge questionnaire, developed by the authors based on behavioral and environmental recommendations intended to promote healthy sleep. Participants were asked to rate statements on a scale from 1 (Strongly Disagree) to 7 (Strongly Agree) based on their knowledge and beliefs about sleep hygiene.

Number	Label	Statement	Source	Correctness
13	Adults' Sleep Patterns	Adults sleep more as they get older.	[31]	False
14	Sleep Quantity	If you can get it, more sleep is always better.	[31]	False
15	Sleep Timing	In terms of your health, it does not matter what time of day you sleep.	[31]	False
16	Rest vs. Sleep	Lying in bed with your eyes closed is almost as good as sleeping.	[31]	False
17	Weekend Sleep	Sleeping in on weekends is a good way to ensure you get adequate sleep.	[32]	False
18	Sleep Difficulties	If you have difficulty falling asleep, it is best to stay in bed and try to fall back to sleep.	[31]	False
19	Snoring	Although annoying for bed partners, loud snoring is mostly harmless	[31]	False
20	Afternoon naps	If you are having difficulties sleeping, taking a nap in the afternoon is a good way to get adequate sleep	[31] [33]	False
21	TV Before Bed	Watching television in bed is a good way to relax before sleep	[31]	False
22	Boredom and Sleepiness	Boredom can make you sleepy even if you got adequate sleep before	[31]	False
23	Exercise and Sleep	Exercising within 4 hours of bedtime will disturb your sleep	[34]	False
24	Sunlight Exposure	Exposure to natural sunlight after waking and again in the late afternoon, prior to sunset, may positively impact sleep quality	[35]	True

Table 3: Version 2 of the Sleep Hygiene Knowledge questionnaire, developed by the authors based on behavioral and environmental recommendations intended to promote healthy sleep. Participants were asked to rate statements on a scale from 1 (Strongly Disagree) to 7 (Strongly Agree) based on their knowledge and beliefs about sleep hygiene. The questionnaire was aimed at measuring the participant's knowledge about routines and techniques impacting sleep quality and their belief in so-called sleep myths.

3.5 Study Design and Procedure of the Investigation

The 30-day intervention was preceded by a one-week pre-intervention phase, in which participants had to complete an initial survey. The sleep of the participants was already being tracked during this time. Afterwards, the 30-day intervention started, in which the participants were presented with a 7-minute exercise video every day. They were recommended to watch the video and follow the exercises directly after waking up in the morning. Furthermore, participants were provided with information on good sleep hygiene and their sleep was tracked with a sleep tracker. This was followed by a one-week post-intervention phase, in which sleep was still tracked. At the end, a final questionnaire was presented to the participants. Depending on which group the participants were assigned to, in addition to a weekly survey (Group 1, 2, and 3) they were asked daily questions about their sleep during the previous night (Group 2 and 3). Group 3 was additionally given feedback weekly about changes in their sleep.

4 Results and Discussion

4.1 Study in Germany

4.1.1 Bergen Insomnia Scale (BIS)

The study was conducted amongst 56 students aged 18 to 30 years (mean age of 23.1 years, 56% female) at TUM, of which all filled out the initial survey and 29 the final survey. In both surveys the participants were asked to complete the Bergen Insomnia Scale (BIS) questionnaire containing six questions (see Table 1), where 0 meant no days during a week and 7 meant every day. The average answers to the BIS questionnaire split up into the three subgroups before (blue) and after (yellow) the study are shown in Figure 1. The key finding derived from Fig. 1 is a notable amelioration in participants' subjective assessments of insomnia symptoms throughout the 44-day duration, observed consistently across all queried domains and experimental subgroups. Also, it is worth noting that the students participating in the study indicated that they struggled most with feeling rested after waking up and overall sleep satisfaction, while waking up at night for
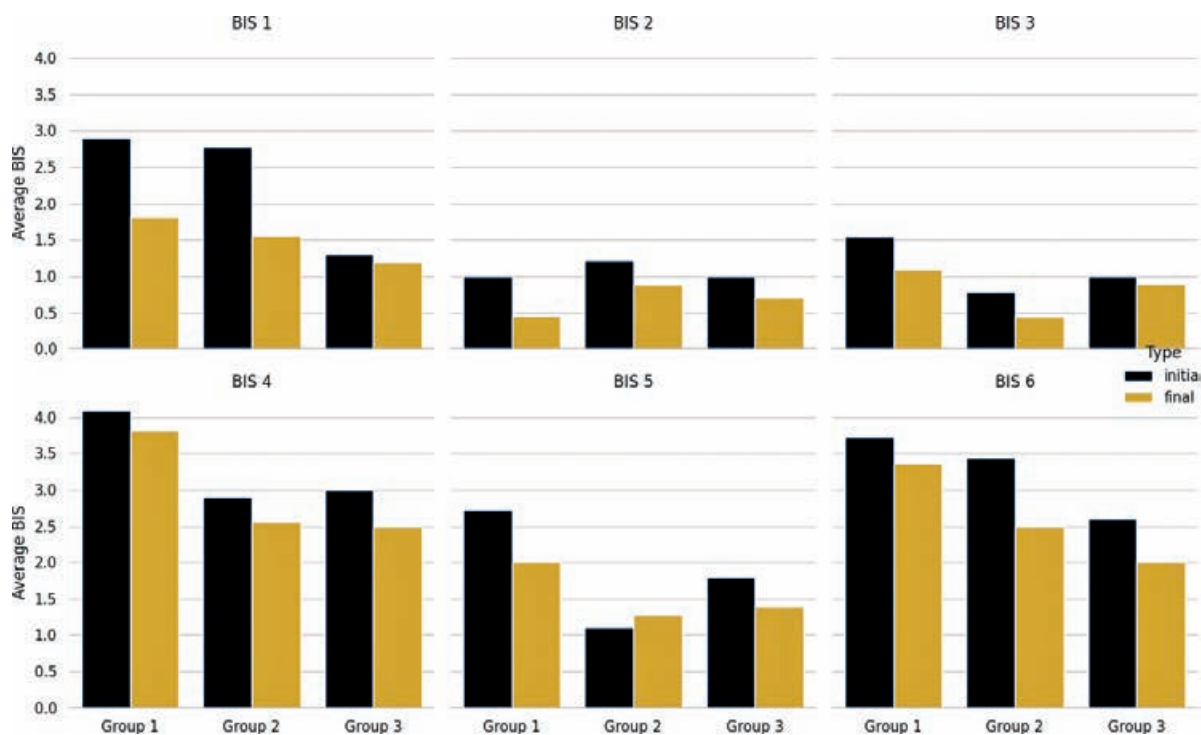
Figure 1: Average answer to the Bergen Insomnia Scale (BIS) questionnaire of all 29 German participants finishing the study, before (blue) and after (yellow) the study, split up into the subgroups

longer periods and waking up earlier than intended were not major issues. A large-scale study amongst 50054 students in Norway conducted in 2018 also used the BIS to assess insomnia [36] and found that 34.2% of female study participants suffered from insomnia while it was only 22.2% in men. Overall a strong increase in insomnia from 22.6% in 2010 to 30.5% in 2018 was observed [36]. The average of 30.5% is because only three in ten participants were men. The criteria for the assessment of whether a participant suffered from insomnia were the following: "(a) the presence of either DIS [Authors' note: DIS stands for "difficulties initiating sleep," and is in the following treated as being equal to question 1 in Table 1], DMS [Authors' note: DMS stands for "difficulties maintaining sleep," and is in the following treated as being equal to question 2 in Table 1] or EMA [Authors' note: EMA stands for "early morning awakening," and is in the following treated as being equal to question 3 in Table 1] for at least 3 nights per week; (b) the presence of daytime sleepiness and tiredness [Authors' note: in the following, this is treated as being equal to any of the questions 4-6 in Table 1] for at least 3 days per week; and (c) a duration of the sleep problems for at least 3 months."

Applying an equivalent method to determine the prevalence of insomnia in our participants prior to the study, excluding the duration criteria (i.e., sleep problems lasting at least 3 months, which were not evaluated), we find that 36% suffered from insomnia before the intervention. This aligns closely with reported rates in Norway.
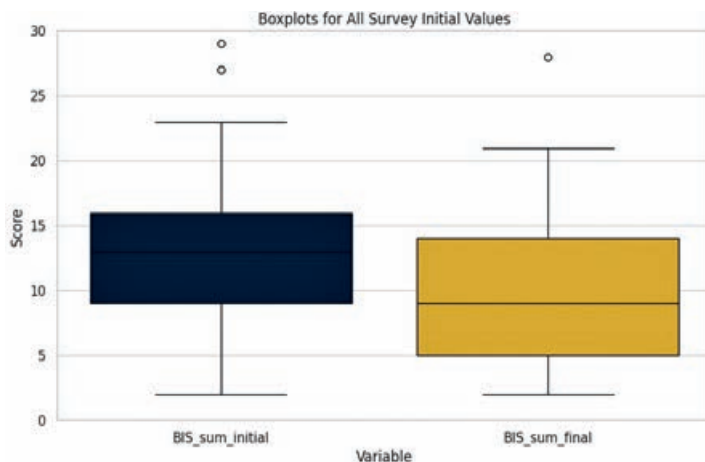
Figure 2: Box plot of the BIS median composite score for the initial (blue) and final survey (yellow)

The median composite score of the BIS in our study before the intervention was 13, and 9 after the intervention (see Fig. 2). In a 2023 study the capability of mindfulness-based cognitive therapy (MBCT) to improve insomnia symptoms was tested in 55 individuals with recurrent depression with a mean age of 40.7 ± 12.9 years, of which 74.5% were females. The intervention lasting 8 weeks was successful in reducing the average composite score of the BIS in the MBCT group by 5.8 points from an initial score of 20.6 ± 8.1 on the BIS score compared to an increase by 1.1 points in the waitlist control group [37]. The mean composite BIS score of the participants who completed the study by filling out the final survey declined by 4 points in our study and by 5 points for participants classified as "insomniacs" at the start of the study. We observed no improvement for participants with no insomnia symptoms at the start of the study. While we did not have a control group in the study, the findings of the participants who completed the study, alongside the findings on the evolution of the waitlist control group of the Norwegian study [37] on MBCT, suggests that our multi-component intervention can help decrease symptoms of insomnia. Moreover, 95% of the participants with insomnia symptoms completed the intervention, indicating a high level of adherence and engagement with the multi-component program for the target group.

To further support the claim of an improvement in insomnia symptoms, we utilized a method known as a "random walk." A random walk describes a process in which a step in any allowed direction is equally likely and determined at random. This method is a good tool to simulate the evolution of a system, especially when multiple external factors introduce unpredictability.

In our case, we studied the evolution of the BIS score over 30 steps, each step representing a day of the intervention. We assume the step size, i.e. how much the score changes from one day to another, to be equal to 1 point on the BIS. We also allow for the BIS score to remain at its current value, which corresponds to a step size of 0.

We then compared a pure random walk, where the likelihood of the BIS score increasing, decreasing, or remaining the same is equal, to a random walk with a trend. In the latter, although the direction of each step remains random, the probability of the BIS score decreasing is greater than the probability of it increasing.

In Fig. 3 we show the evolution of the standard deviation and mean for the pure random walk method (blue) and the random walk with

a trend (orange) averaged over 30 trials. In each trial we bounded the BIS scores to lie within [0, 42] by ignoring steps that would exceed these bounds. In the blue random walk, we assume equal probabilities of one-third for each of the following outcomes: an increase, a decrease, or no change in the BIS score. On the other hand, the orange random walk assumes a one-third probability for the BIS score to remain the same at each step, a 45% probability of a decrease, and only a 22% probability of an increase.

While the specific values of the random walk simulation may not describe the actual evolution perfectly (for instance, we expect the improvement to not kick in from the start and flatten with increased time), the simulation serves as a visualization of the positive impact our intervention has.
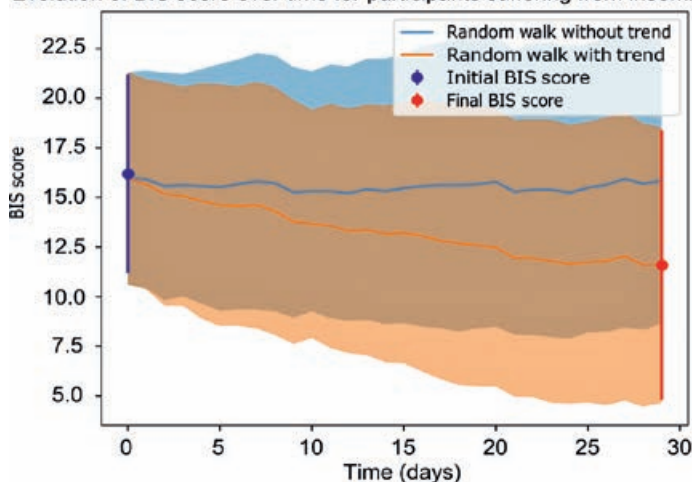
Figure 3: The blue (initial) and red (final) error bars show the mean and standard deviation of the initial and final BIS scores of participants with insomnia symptoms, while the blue (equal probability of increasing p_{worse} and decreasing p_{better} the BIS score) and orange (p_{better}/p_{worse} = 1.35) lines show the evolution of the mean BIS scores and standard deviations assuming an underlying random walk.

4.1.2 Sleep Hygiene Knowledge

The sleep myths were debunked, and sleep hygiene knowledge was disseminated during the 30-day intervention by including a short fact at the end of the workout videos the participants were supposed to watch each morning. These sleep facts addressed all the statements given in the initial survey.

After the intervention, the participants got a survey again including the BIS questionnaire and the sleep hygiene knowledge questionnaire with the same set of questions.

We expect the answers regarding sleep myths to follow a bimodal distribution with participants either believing them to be correct or incorrect. For these questions we report the percentage of agreement and disagreement and their certitude, as the average value within the two subgroups (see Table 2).

For the questions on knowledge that impacts sleep quality that is not directly tied to a sleep myth, we expect the answers to be normally distributed with a mean of 3.5, meaning there is no knowledge about the technique/ routine among the study population.

26 out of the 54 initial participants filled out the final survey, and only those 26 were considered for the evaluation of the sleep hygiene knowledge improvement. To assess how their sleep hygiene knowledge changed, the difference between the answered value was calculated, where a positive difference means they became more sure of the correct answer. The result is shown in Figure 4 per participant and question.

To analyze the overall improvement per participant, the differences were then summed up, so that a lowest value of -72 could be reached for maximum deterioration, or a high of 72 for highest possible improvement. As seen in Figure 5, the mean improvement is at 0.38, with the median value at 0.5. This increase is not significant. One reason could have been that the participants only got the correct information once and a retention of the information over an extended period is unlikely. However, we expected "motivated" participants to improve nevertheless either by reading up on sleep hygiene knowledge privately or by paying close attention to the information in the videos, and by incorporating the positive tips into their daily routines and avoiding habits with negative impact on their sleep.

4.1.3 Motivation of participants

To assess the impact of incentives for active reflection and providing feedback on the motivation of the participants two main data points were analyzed: The number of participants that dropped out of the study and the time they spent watching the daily video. As threshold for a participant to be considered as "dropped out" we defined skipping two videos in a row or five videos in total. Monitor-

ing dropout rates is generally essential to monitor as they can impact the validity and reliability of study results. High dropout rates may indicate issues with participant engagement, study design, or intervention effectiveness.

An overview of initial number of participants, total dropouts and the percentage of dropouts for each study group is shown in Figure 6. Group one exhibits the highest dropout rate, with more than 60%, while group two has a rate of about 50% and in group three, less than 40% dropped out.
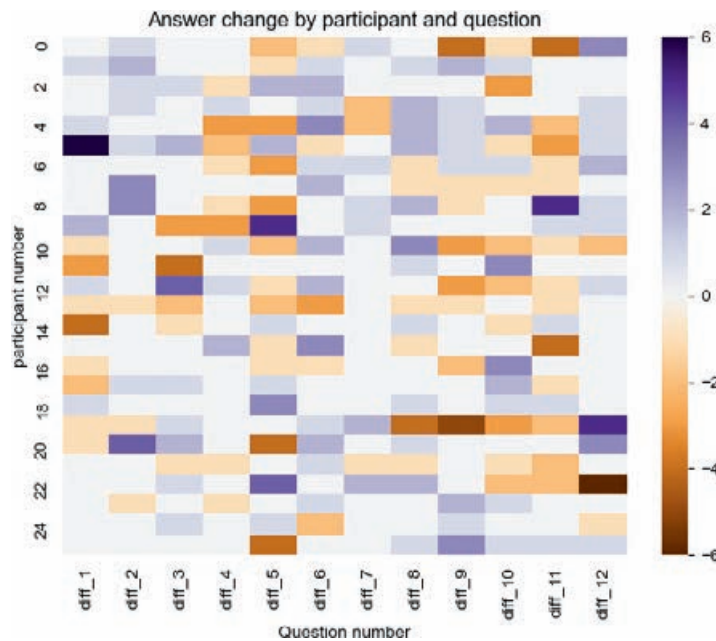
Figure 4: Difference in answer confidence per participant and question. Both question sets one and two are combined.survey (yellow)

This suggests potential concerns with participant engagement or the effectiveness of the video-only intervention. Based on these results, strategies to improve participant retention, such as enhancing intervention content, providing incentives, or implementing reminders, seem more effective than only providing the routine content. Further investigation of reasons for dropout, such as participant demographics, preferences, or study-related factors, could

promote development of targeted interventions to mitigate dropout rates and improve overall study success.

The second metric investigated is the time the participants spent on the survey page with the video. Spending less time than the video duration might imply a loss of interest or skipping parts of the intended routine. Based on the length of the videos, where the shorter ones are about 367 seconds and some time was deducted for intros and outros, a threshold of 350 seconds was set for a participant to have spent 'enough' time on that website. From the p-values calculated for the results shown in Figure 7, no significant difference between the groups could be found.

Figure 5: Answer confidence differences summed up per participant.

4.2 Study in Ghana

After the study in Munich concluded, the team traveled to Kwame Nkrumah University of Science and Technology (KNUST) to set up the study there as well. The same study design as described in section 3 was used. Because of time constraints and significant differences in how student projects are approached in Ghana, the way participants were selected differed: In Germany, all students could voluntarily join if they had interest in the topic of sleep improvement, and they were only incentivized by advertisement or word of mouth.

At KNUST however, advertisement possibilities were limited, so most of the communication to students was through visiting lectures and introducing the project. Afterwards, to help gain enough participants, the lecturers advised certain students of their classes to join our program. The selection of students was based on their perceived reliability in handling and returning the sleep trackers that were given out.

This factor might have led to a different general motivation to participate in the study compared to the German students. It is therefore important to note that it is difficult to amalgamate the two data sets

from Germany and Ghana. Some comparisons of notable values are shown in the following, but they have to be viewed with caution.

4.3 Difference in Sleep Hygiene Knowledge and BIS score between Ghana and Germany

As part of our study, we investigated how sleep routines and habits, motivation, and knowledge vary between different regions of the world, specifically Germany and Ghana, and how this affects the outcome of the 30-day sleep quality and sleep routine improvement program. Independent of the differences between the studies in Germany and Ghana, outlined in section 4.2, an assessment of different sleep hygiene knowledge in Germany vs. Ghana was done. Fig. 8 shows the average scores for sleep hygiene knowledge questions from 1 (Strongly Disagree) to 7 (Strongly Agree) of Tables 2 and 3 in Germany and Ghana sorted in descending order by the difference in points between the German and the Ghanaian students' answers.
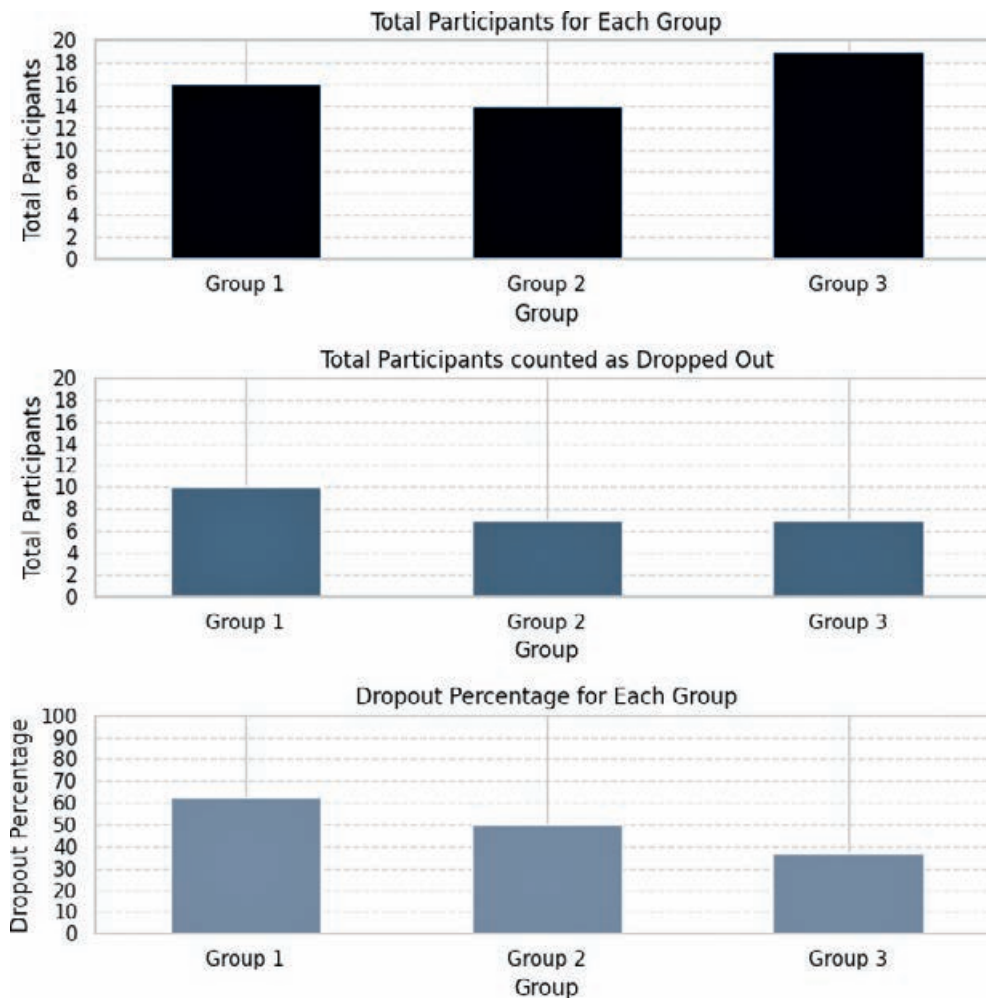
Figure 6: Counts of all participants (top), dropped out participants (middle), and the dropout percentage (bottom) for each of the subgroups.
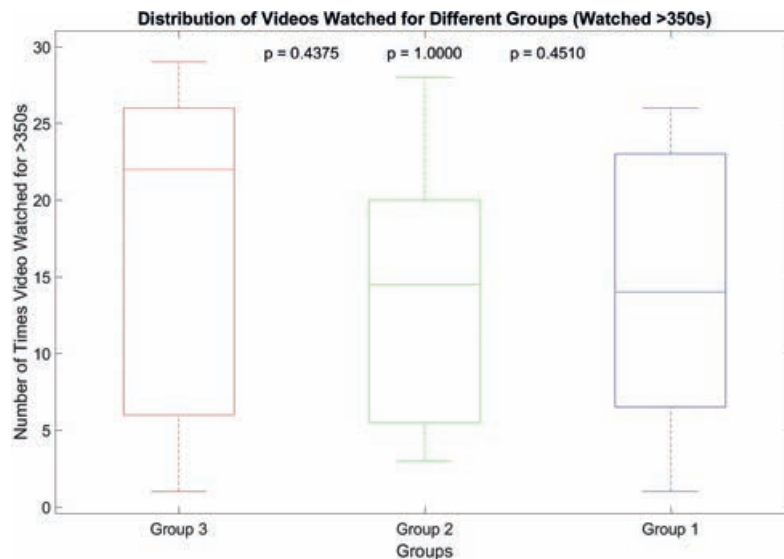
Figure 7: Amount of Videos watched for more than 350s based on total time spent on the webpage, for Group 1 (right), Group 2 (middle) and Group 3 (left)

It is worth noting that there was a significant discrepancy (over 1.5 points) in the average agreement with the top 10 statements. Also, for statements 21, 14, 6, 18, 9, and 17, the German students tended to disagree more, while the Ghanaian students tended to agree more with the statements.

A more precise comparison for each question is depicted in Figure 9, in which the six questions with the biggest difference were compared using boxplots for each of the two participant groups. Particularly noteworthy is the difference in confidence for particular questions. While for question 21 and 14, German students were more undecided in their answer, Ghanaian students showed a much more uniform agreement with the statements. On the other hand for question 11, German participants were very uniform in their denial of the thesis, while Ghanaian participants were much more undecided.

Figure 10 shows a similar comparison of pre- and post-intervention BIS scores for the participants of the Ghana study. While the improvement was even less than for German participants, it is worth noting that participants in Ghana started with a much higher BIS score on average than German participants.

	Merged_df_Avg	Initial_Ghana_Avg	Difference
Hygiene_21	2.411765	5.391304	2.979540
Hygiene_14	3.470588	6.260870	2.790281
Hygiene_6	2.538462	5.318182	2.779720
Hygiene_11	1.461538	3.545455	2.083916
Hygiene_18	3.235294	5.217391	1.982097
Hygiene_9	3.538462	5.409091	1.870629
Hygiene_15	2.176471	4.000000	1.823529
Hygiene_17	3.647059	5.347826	1.700767
Hygiene_3	3.307692	4.909091	1.601399
Hygiene_7	1.307692	2.772727	1.465035
Hygiene_13	2.352941	3.652174	1.299233
Hygiene_16	2.529412	3.565217	1.035806
Hygiene_12	1.692308	2.727273	1.034965
Hygiene_24	5.529412	4.652174	0.877238
Hygiene_20	4.294118	5.086957	0.792839
Hygiene_4	6.000000	5.272727	0.727273
Hygiene_5	5.538462	4.818182	0.720280
Hygiene_22	4.882353	5.521739	0.639386
Hygiene_19	3.294118	3.869565	0.575448
Hygiene_10	3.000000	3.545455	0.545455
Hygiene_23	3.764706	4.173913	0.409207
Hygiene_2	6.615385	6.272727	0.342657
Hygiene_1	6.076923	5.909091	0.167832
Hygiene_8	6.076923	6.227273	0.150350

Figure 8: The figure shows the average scores reflecting the agreement/disagreement with the statements provided in the sleep hygiene knowledge questionnaire between the study participants from the Technical University of Munich in Germany and the participants from the Kwame Nkrumah University of Science and Technology in Ghana, sorted by the difference between the German and Ghanaian students.
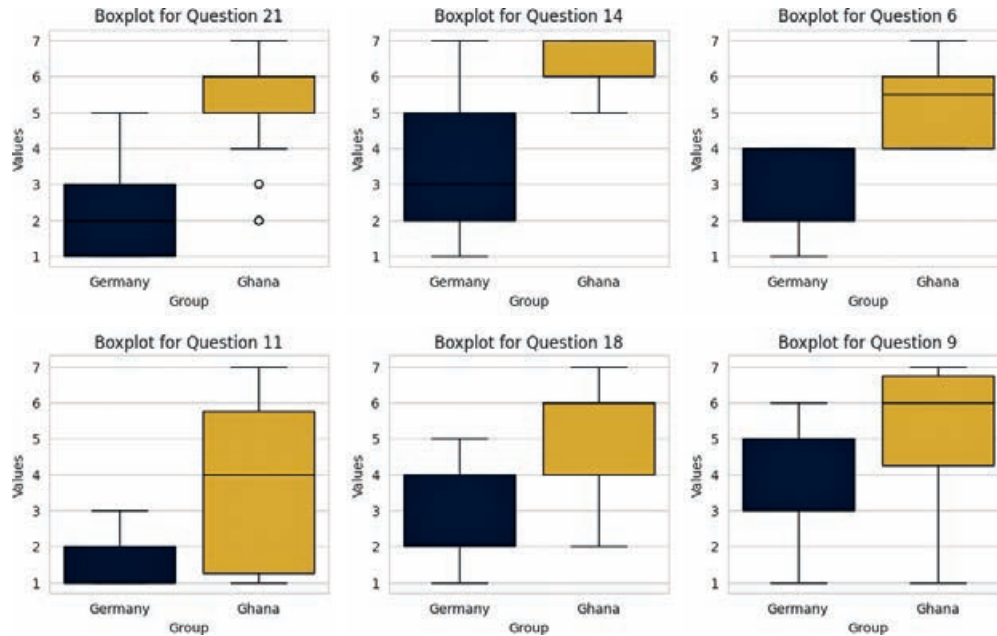
Figure 9: Boxplots for the six questions with the biggest average knowledge difference between the countries, each time comparing German (blue) and Ghanaian (yellow) students. The exact questions are stated in Table 2 and Table 3
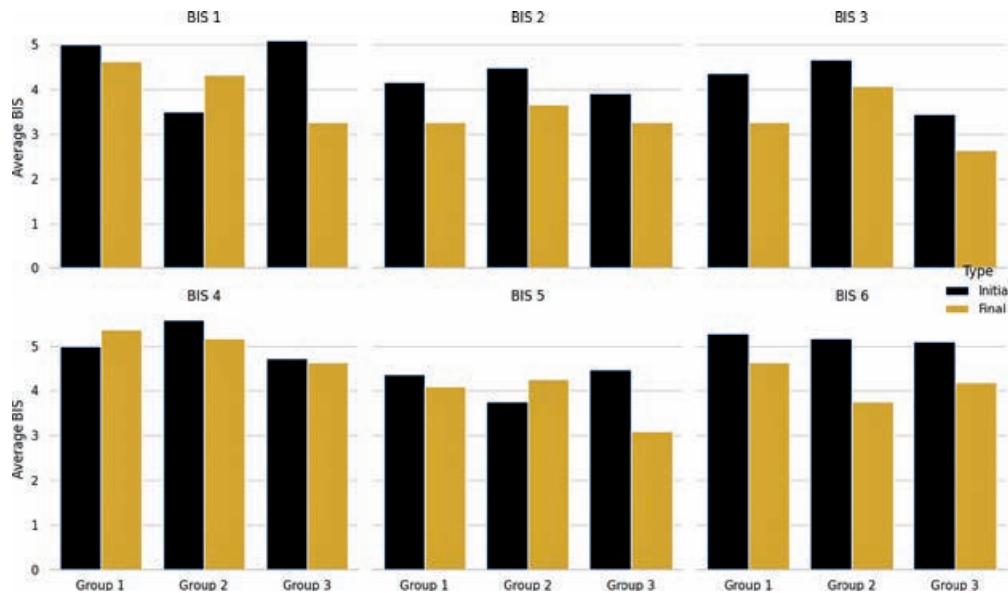
Figure 10: Average answer to the Bergen Insomnia Scale (BIS) questionnaire of Ghanaian participants, before (blue) and after (yellow) the study, split up into the subgroups

5 Conclusion

The observed reduction of BIS scores across all subgroups with a median composite score decreasing from 13 before the intervention to 9 afterwards, coupled with the significant improvement noted in participants identified as "insomniacs" at the study's outset, provides some evidence that the multi-component intervention including sleep education, physical exercise, and relaxation techniques, has a positive impact on subjects suffering from insomnia. Furthermore, the high completion rate of 95% among participants with insomnia symptoms, suggests that the intervention achieved a high attention rate and thus has the potential to address sleep disturbances effectively, especially among university students.

Significant differences between the subgroups 1 (only weekly surveys), 2 (weekly survey and daily questionnaire) and 3 (weekly survey, daily questionnaire and feedback on sleep quality), indicating that receiving feedback and incentives for active reflection are essential for enhancing sleep quality over the 30-day period were not observed. However, the lower dropout rates for the group receiving feedback and reflecting on their sleep by keeping a sleep diary suggests that motivation for study continuation is impacted. The non-significant level of improvement in sleep hygiene knowledge before and after the study suggests that a brief sleep fact presented after a daily workout routine may not suffice to enhance understanding of positive sleep practices. Thus, future interventions may benefit from exploring alternative techniques for disseminating knowledge to enhance this aspect of the intervention.

6 Acknowledgements

References

[1] Kana Okano et al. "Sleep quality, duration, and consistency are associated with better academic performance in college students". In: npj Science of Learning 4 (1 Oct. 2019), p. 16. issn: 2056-7936. doi: 10.1038/s41539-019-0055-z.

[2] Mark Lawrence Wong et al. "The interplay between sleep and mood in predicting academic functioning, physical health and psychological health: A longitudinal study". In: Journal of Psychosomatic Research 74 (4 Apr. 2013), pp. 271–277. issn: 00223999. doi: 10.1016/j.jpsychores.2012.08.014.

[3] Andrew M. Watson. "Sleep and Athletic Performance". In: Current Sports Medicine Reports 16 (6 Nov. 2017), pp. 413–418. issn: 1537-8918. doi: 10.1249/JSR.0000000000000418.

[4] Jean-Philippe Chaput et al. "Sleep timing, sleep consistency, and health in adults: A systematic review". In: Applied Physiology, Nutrition, and Metabolism 45.10 (Suppl. 2) (Oct. 2020). doi: 10.1139/apnm-2020-0032.

[5] Biliana Marcheva et al. "Circadian Clocks and Metabolism". In: 2013, pp. 127–155. doi: 10.1007/978-3-642-25950-0_6.

[6] Francesco P. Cappuccio et al. "Meta-Analysis of Short Sleep Duration and Obesity in Children and Adults". In: Sleep 31 (5 May 2008), pp. 619–626. issn: 0161-8105. doi: 10.1093/sleep/31.5.619.

[7] Tae Won Kim, Jong-Hyun Jeong, and Seung-Chul Hong. "The Impact of Sleep and Circadian Disturbance on Hormones and Metabolism". In: International Journal of Endocrinology 2015 (2015), pp. 1–9. issn: 1687-8337. doi: 10.1155/2015/591729.

[8] William H. Walker et al. "Circadian rhythm disruption and mental health". In: Translational Psychiatry 10 (1 Jan. 2020), p. 28. issn: 2158-3188. doi: 10.1038/s41398-020-0694-0.

[9] June C. Lo et al. "Self-reported sleep duration and cognitive performance in older adults: a systematic review and meta-analysis". In: Sleep Medicine 17 (Jan. 2016), pp. 87–98. issn: 13899457. doi: 10.1016/j.sleep.2015.08.021.

[10] "The Global Problem of Insufficient Sleep and Its Serious Public Health Implications". In: Healthcare 7 (1 Dec. 2018), p. 1. issn: 2227-9032. doi: 10.3390/healthcare7010001.

[11] National Center for Chronic Disease Prevention Division of Population Health and Health Promotion. Sleep and sleep disorders. Sept. 2022. url: https://www.cdc. gov/sleep/index.html.

[12] "Insomnia disorder: State of the science and challenges for the future". In: Journal of Sleep Research 31 (4 Aug. 2022). issn: 0962-1105. doi: 10.1111/jsr.13604.

[13] Andrew Stickley et al. "Sleep problems and depression among 237 023 community-dwelling adults in 46 low- and middle-income countries". In: Scientific Reports 9 (1 Aug. 2019), p. 12011. issn: 2045-2322. doi: 10.1038/s41598-019-48334-7.

[14] Dieter Riemann et al. "European guideline for the diagnosis and treatment of insomnia". In: Journal of Sleep Research 26 (6 Dec. 2017), pp. 675–700. issn: 0962-1105. doi: 10.1111/jsr.12594.

[15] Saverio Stranges et al. "Sleep Problems: An Emerging Global Epidemic? Findings From the INDEPTH WHO-SAGE Study Among More Than 40,000 Older Adults From 8 Countries Across Africa and Asia". In: Sleep 35 (8 Aug. 2012), pp. 1173–1181. issn: 0161-8105. doi: 10.5665/sleep.2012.

[16] "Why Sleep Matters - The Economic Costs of Insufficient Sleep: A Cross-Country Com- parative Analysis." In: Rand health quarterly 6 (4 Jan. 2017), p. 11. issn: 2162-8254.

[17] Uthman Albakri, Elizabeth Drotos, and Ree Meertens. "Sleep Health Promotion Inter- ventions and Their Effectiveness: An Umbrella Review". In: International Journal of Environmental Research and Public Health 18 (11 May 2021), p. 5533. issn: 1660-4601. doi: 10.3390/ijerph18115533.

[18] Lie °Aslund et al. "Cognitive and Behavioral Interventions to Improve Sleep in School-Age Children and Adolescents: A Systematic Review and Meta-Analysis". In: Journal of Clinical Sleep Medicine 14 (11 Nov. 2018), pp. 1937–1947. issn: 1550-9389. doi: 10.5664/jcsm.7498.

[19] Sarah L. Blunden, Janine Chapman, and Gabrielle A. Rigney. "Are sleep education programs successful? The case for improved and consistent research efforts". In: Sleep Medicine Reviews 16 (4 Aug. 2012), pp. 355–370. issn: 1087-0792. doi: 10.1016/J. SMRV.2011.08.002.

[20] Phillippa Lally et al. "How are habits formed: Modelling habit formation in the real world". In: European Journal of Social Psychology 40 (6 Oct. 2010), pp. 998–1009. issn: 1099-0992. doi: 10.1002/EJSP.674. url: https://onlinelibrary.wiley.com/doi/ full/10.1002/ejsp.674% 20https://onlinelibrary.wiley.com/doi/abs/10.1002/ejsp.674%20https://onlinelibrary.wiley.com/doi/10.1002/ejsp.674.

[21] St˚ale Pallesen et al. "A New Scale for Measuring Insomnia: The Bergen Insomnia Scale". In: Perceptual and Motor Skills 107 (3 Dec. 2008), pp. 691–706. issn: 0031-5125. doi: 10.2466/pms.107.3.691-706.

[22] American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disor- ders. 4th. American Psychiatric Association, 1994.

[23] Daniel P. Windred et al. "Sleep regularity is a stronger predictor of mortality risk than sleep duration: A prospective cohort study". In: Sleep 47 (1 2024). issn: 15509109. doi: 10.1093/sleep/zsad253.

[24] Christopher Drake et al. "Caffeine Effects on Sleep Taken 0, 3, or 6 Hours before Going to Bed". In: Journal of Clinical Sleep Medicine 09 (11 Nov. 2013), pp. 1195–1200. issn: 1550-9389. doi: 10.5664/jcsm.3170.

[25] Carolin Franziska Reichert, Tom Deboer, and Hans-Peter Landolt. "Adenosine, caffeine, and sleep–wake regulation: state of the science and perspectives". In: Journal of Sleep Research 31 (4 Aug. 2022). issn: 0962-1105. doi: 10.1111/ jsr.13597.

[26] Christine Blume, Corrado Garbazza, and Manuel Spitschan. "Effects of light on human circadian rhythms, sleep and mood". In: Somnologie 23 (3 Sept. 2019), pp. 147–156. issn: 1432-9123. doi: 10.1007/s11818-019-00215-x.

[27] CATHERINE E. MILNER and KIMBERLY A. COTE. "Benefits of napping in healthy adults: impact of nap length, time of day, age, and experience with napping". In: Journal of Sleep Research 18 (2 June 2009), pp. 272–281. issn: 0962-1105. doi: 10. 1111/j.1365-2869.2008.00718.x.

[28] Amber Brooks and Leon Lack. "A brief afternoon nap following nocturnal sleep restriction: Which nap duration is most recuperative?" In: Sleep 29 (6 2006). issn: 01618105. doi: 10.1093/sleep/29.6.831.

[29] Namni Goel et al. "Circadian Rhythms, Sleep Deprivation, and Human Performance". In: Progress in Molecular Biology and Translational Science 119 (Jan. 2013), pp. 155–190. issn: 1877-1173. doi: 10.1016/B978-0-12-396971-2.00007-5.

[30] "Sleep inertia, sleep homeostatic and circadian influences on higher-order cognitive functions". In: Journal of Sleep Research 24 (4 2015). issn: 13652869. doi: 10.1111/ jsr.12291.

[31] Rebecca Robbins et al. "Sleep myths: an expert-led study to identify false beliefs about sleep that impinge upon population sleep health practices". In: Sleep Health 5 (4 Aug. 2019), pp. 409–417. issn: 2352-7218. doi: 10.1016/J. SLEH.2019.02.002.

[32] Amanda Taylor, Helen R. Wright, and Leon C. Lack. "Sleeping-in on the weekend delays circadian phase and increases sleepiness the following week". In: Sleep and Biological Rhythms 6 (3 2008). issn: 14469235. doi: 10.1111/j.1479-8425.2008.00356.x.

[33] Melodee Mograss et al. "The effects of napping on night-time sleep in healthy young adults". In: Journal of Sleep Research 31 (5 2022). issn: 13652869. doi: 10.1111/jsr. 13578.

[34] Jan Stutz, Remo Eiholzer, and Christina M. Spengler. "Effects of Evening Exercise on Sleep in Healthy Participants: A Systematic Review and Meta-Analysis". In: Sports Medicine 49 (2 Feb. 2019), pp. 269–287. issn: 0112-1642. doi: 10.1007/ s40279-018-1015-0.

[35] Anna Wirz-Justice, Debra J. Skene, and Mirjam Mu¨nch. "The relevance of daylight for humans". In: Biochemical Pharmacology 191 (Sept. 2021), p. 114304. issn: 0006-2952. doi: 10.1016/J.BCP.2020.114304.

[36] Børge Sivertsen et al. "Sleep patterns and insomnia in young adults: A national survey of Norwegian university students". In: Journal of Sleep Research 27.6 (2018), e12790. doi: 10.1111/jsr.12790.

[37] A. Grivas, J. Smith, and R. Johnson. "Mindfulness-based cognitive therapy improves insomnia symptoms in individuals with recurrent depression: secondary analyses from a randomized controlled trial". In: Frontiers in Psychiatry 14 (2023), ArticlePage. doi: 10.3389/fpsyt.2023.1231040. url: https://www.frontiersin.org/ journals/ psychiatry/articles/10.3389/fpsyt.2023.1231040/full.

Self-reflection
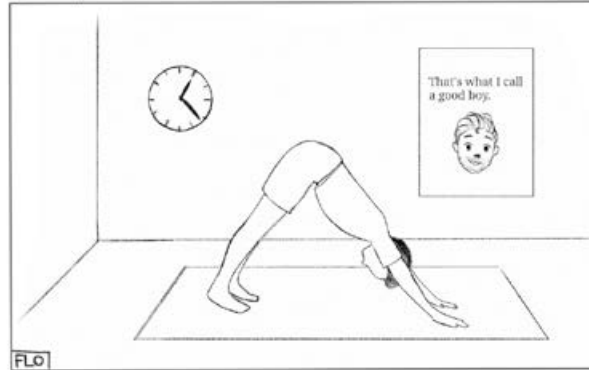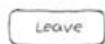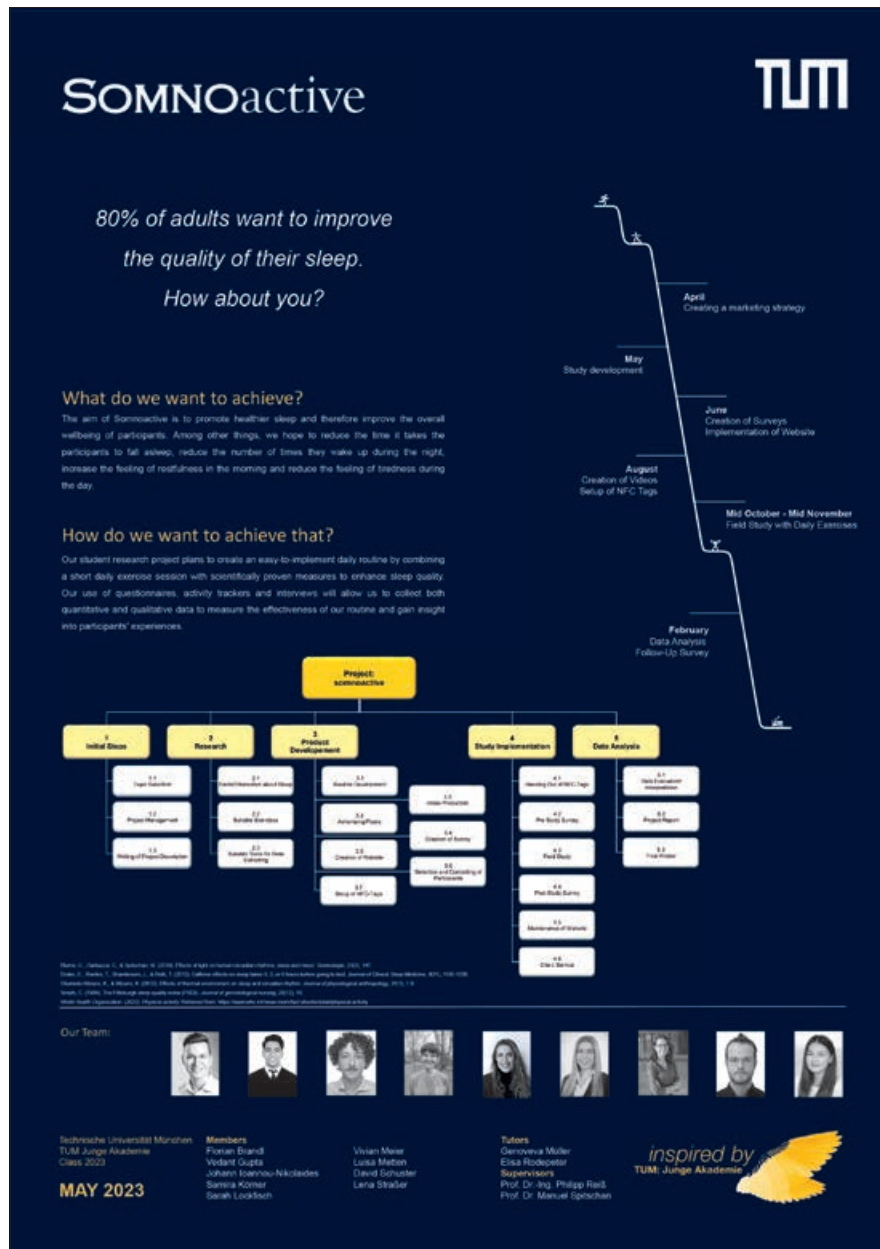
POSTER 1:

Starting from the kick-off weekend in November 2022, we initially wanted to develop pilot projects on the subject of air pollution. After encountering several practical difficulties with that, we reconsidered within the group and decided to focus on the topic of sleep in combination with physical activity instead. The intent of our group "Somnoactive" was to promote healthier sleep and to improve the overall wellbeing of participants. Therefore, we planned to create an easy-to-implement daily routine by combining a short exercise with scientifically proven measures to enhance students' sleep quality.

To get a deeper insight into the topic, we conducted thorough research on the subject of sleep and adequate exercises as well as suitable tools for data collection.

POSTER 2:

After finishing our main research, we formulated a research question and a hypothesis for our study and defined a concrete study design.

Within four subgroups, it was our goal to advance the study as effectively as possible: While one team addressed the ethical aspects of our study, another group worked on the planning and implementation of the daily exercise videos we wanted to present to our participants. In addition, a third team took care of the project marketing and acquisition of participants and the last group dealt with how the videos and surveys could be made available to the participants.

POSTER 3:

After our study was promoted successfully, all exercise videos were recorded and everything was prepared, the project started on November 2, 2023, with students mainly from TUM – a first milestone of our project was realized. We were able to collect data throughout the 30-day-intervention and during pre- and post-intervention periods of one week each. We also started to evaluate the data and gained a first insight into the results.

Besides that, we planned a trip to Kwame Nkrumah University of Science and Technology (KNUST) in Kumasi/Ghana, a partner university of TUM, to conduct the same study there. ■

POSTER 4:

Right after a TUMJA weekend seminar in January 2024, five members of our team travelled to Kumasi/Ghana for one week to prepare and help with the start of the study on site at KNUST. Besides this scientific aspect, we were also able to meet great personalities and to gain amazing insights into the country, its culture and its customs – an incredible and unique experience.

We continued with data evaluation, compiled the most important results and finished the writing of our research report.

During the final stage of the scholarship program, we planned the presentation of our project at the TUMJA symposium in June 2024.