An Experimental Evaluation on the Effect of Dynamic Chairs on Students' Behaviour, Movement, and Academic Achievement in Mathematics

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Abstract

Traditional classroom chairs are often rigid and inflexible, resulting in uncomfortable static sitting. Conversely, dynamic chairs are designed to promote healthy movement and comfort, which is hypothesised to improve student engagement, reduce disruptive behaviour, and, in turn, improve academic achievement. Currently, there is a lack of research into the effects of dynamic chairs on students' behaviour and outcomes compared to regular classroom chairs. This thesis comprises a series of studies that investigate the effect of BodyfurnFlex chairs, a new type of dynamic chair, on the behaviour, movement, achievement, and perceptions of students compared with traditional classroom chairs.

In Study 1, I used a multiple baseline ABAB reversal design to investigate the effect that BodyfurnFlex chairs had on students' behaviour and movement in comparison to regular classroom chairs. Additionally, a survey was used to assess students' perceptions of the chairs, while classroom environmental conditions were monitored as potential confounding variables. The results showed that BodyfurnFlex chairs significantly increased students' on-task behaviour and reduced disruptive behaviours, including chair tipping and out-of-seat behaviour. Meanwhile, both in-chair and overall movement in the classroom increased when students were seated in BodyfurnFlex chairs. The majority of participants preferred BodyfurnFlex chairs, finding them more comfortable and believing they made it easier to complete their schoolwork. The environmental conditions in the classroom remained within the recommended levels throughout data collection, indicating they were not confounding variables in this study.

In Study 2, I conducted a detailed analysis of the movement and environmental data collected in Study 1. This included analysing different aspects of the in-chair movement data, including displacement, acceleration, and rotation. Additionally, I examined whether BodyfurnFlex chairs could influence noise levels in classrooms and explored possible connections between movement, environmental, noise, and behavioural variables. The results showed that both in-chair displacement and acceleration significantly increased when students sat in BodyfurnFlex chairs.

However, while displacement was not associated with students' behaviour, acceleration was, suggesting that student behaviour is not related to how much students move but rather how consistently they move. Noise levels in the classroom had a significant negative correlation with on-task behaviour and decreased when students sat in BodyfurnFlex chairs. All environmental variables (CO_2, temperature, and humidity) showed small, non-significant correlations with all other variables, indicating that they were not confounding factors.

In Study 3, I investigated the effect of BodyfurnFlex chairs on students' academic achievement across multiple mathematics assessments using a pre-post intervention between-groups design. Additionally, focus group discussions were conducted to gain greater insight into teachers' and students' perceptions of the chairs. The results showed no significant difference in test grades between students who used the BodyfurnFlex chairs and those who used regular chairs. However, several limitations around the results, including the testing/grading system and design, are discussed. Students reported far greater satisfaction with BodyfurnFlex chairs compared to the regular chairs, stating that they were more comfortable and functional, aided their ability to do their schoolwork, and felt they had a positive effect on their test results.

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Preface

This thesis is presented as a PhD with a publication, written from a behaviour analysis perspective. It begins with a brief Introduction chapter that presents the main concepts and justification for the research, details background information on the researcher and project stakeholders, and provides an overview of the thesis. This is followed by a Literature Review that offers an in-depth explanation of the main concepts, situating them within the broader body of research. Next, a Methodology chapter provides a detailed rationale for the methodology used in this research, explains the research approach and underpinning theoretical framework, discusses ethical considerations and how they were addressed, and includes additional details that could not be included in the manuscripts. The main body of the thesis consists of three studies, each presented as an independent, stand-alone paper, some of which have been submitted for publication. The thesis concludes with a General Discussion chapter that synthesises the key findings from the studies, interpreting them within the existing literature. Due to its structure, there is some repetition of content across sections.

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Chapter 1: Introduction

Academic achievement is often regarded as a key indicator of students' success in their educational journey. Its significance extends beyond the classroom, as it plays a crucial role in shaping an individual's future quality of life (Edgerton et al., 2012; Starr et al., 2024). However, according to a recent OECD report, academic achievement in New Zealand has been steadily declining over the past two decades (OECD, 2024). Between 2009 and 2022, New Zealand's average score in the OECD Program for International Student Assessment (PISA) test declined by the equivalent of two years of education in mathematics, 18 months in science, and one year in reading (OECD, 2024).

A key factor that can significantly influence academic achievement is student behaviour (Blank & Shavit, 2016; Flores-Mendoza et al., 2013; Wong et al., 2024). According to the Education Review Office, poor student behaviour, including disruptive behaviour (behaviour that interferes with teaching or learning of other students) and lack of student engagement (active involvement in learning tasks and activities), are major factors contributing to low achievement in New Zealand schools (Education Review Office, 2024). The report revealed that over the last 20 years, New Zealand classrooms have consistently had worse behaviour compared to most other OECD nations, including the worst among all countries in maths classes. To tackle the issue of poor behaviour, the Education Review Office emphasised the importance of schools adopting interventions/strategies that address the underlying causes of poor behaviour, rather than just addressing the behaviour itself (Education Review Office, 2024).

One potential solution to improving student behaviour is through classroom seating. Regular/standard classroom chairs are typically monobloc (single-piece) plastic chairs that are rigid and inflexible, leading to static sitting (sitting in the same position without moving). Prolonged static sitting can cause pain/discomfort (Caromano et al., 2015; Waongenngarm et al., 2015), which can lead to decreased engagement (Aga, 2024; Hanaysha et al., 2023; Scott-Webber et al., 2018), and students engaging in disruptive behaviours like out-of-seat behaviour (leaving seat without

permission) and chair tipping (swinging/rocking on chairs), in an effort to relieve discomfort (Knight & Noyes, 1999; Morishima et al., 2016). The current literature suggests that, in addition to having a negative effect on student engagement, static sitting may be a motivating operation, an environmental factor that increases the likelihood of a specific behaviour occurring (Cooper et al., 2020), for engaging in disruptive behaviours such as chair tipping and out-of-seat behaviour.

Unlike regular classroom chairs, dynamic chairs are designed to be flexible and promote natural, non-disruptive movement through active sitting (consistent movement through postural changes). Dynamic chairs have been shown to significantly increase the movement of occupants compared to regular (non-dynamic) chairs (Grooten et al., 2017; Nüesch et al., 2018; Tanoue et al., 2016) and reduce pain/discomfort (Cardenas et al., 2024; Frey et al., 2021; Garcia et al., 2016). These findings suggest that dynamic chairs could be an effective intervention for improving student engagement by reducing uncomfortable static sitting, thereby removing the motivating operation for students to engage in disruptive behaviours such as chair tipping and out-of-seat behaviour.

Although the current literature suggests that dynamic chairs could enhance student behaviour and, in turn, achievement, this is not yet supported by empirical evidence, as there is a lack of research examining the impact of dynamic chairs on students' behaviour and outcomes (Rollo et al., 2019). Despite the lack of evidence, many schools are transitioning from traditional classroom chairs and investing in more expensive dynamic chairs and other flexible seating options under the belief that they can enhance students' learning (Anderson & Hartley, 2018; Attai et al., 2021; Cole et al., 2021; Putman et al., 2024). The aim of the current research was to fill this gap in the literature by investigating whether dynamic chairs are an effective intervention for improving student behaviour and achievement, and why.

Research Support

As part of this research, I partnered with Resero (Resero, n.d.), a New Zealand-based innovative furniture company, which supplied the dynamic chairs used in this research, the BodyfurnFlex chair (Furnware, n.d.). This chair is a new type of dynamic chair developed by one of

their subsidiaries, Furnware (Furnware, n.d.-b). Resero also provided the Smart Classroom System, a novel data-collection tool designed to monitor various types of movement in the classroom, with the aim of examining how different chairs affect student movement and how this, in turn, influences their behaviour.

Additionally, the system also measures several environmental factors, including carbon dioxide (CO_2), temperature, humidity, and noise levels, all of which can significantly impact students' learning (Caviola et al., 2021; Haverinen-Shaughnessy & Shaughnessy, 2015; Liu et al., 2021) and health (Angelon-Gaetz et al., 2016; Jaakkola et al., 2014; Tu et al., 2021). Despite evidence indicating that many New Zealand classrooms do not meet the Ministry of Education's requirements for environmental conditions (Building Research Association of New Zealand, 2019a, 2019b), there is a lack of technology capable of reliably and efficiently assessing these conditions. Therefore, this research includes these factors to assess whether the Smart Classroom System can accurately measure them and if this technology could serve as a useful tool for assessing the quality of learning spaces.

The current research received funding, including a student stipend and a university host fee (for general administration) (contract number: FURNW2102), from Callaghan Innovation (Callaghan Innovation, n.d.), a government agency that supports New Zealand businesses through research and development (R&D) funding.

Researcher

I, Isaac Martin, am a Psychology PhD student at the University of Waikato and hold a Bachelor of Science majoring in Psychology and a Master of Applied Psychology in Behaviour Analysis. I have prior experience conducting behaviour-analytic research in schools, most notably my master's thesis, Martin (2021), which served as the pilot study and a primary justification for the current research. I have previously worked with the project stakeholders, Resero, as part of my master's research (Martin, 2021), during which they provided research support and equipment. I had

no prior relationship with any of the schools, teachers, or students who participated in the current research.

Overview of the Current Research

In the current research, I sought to answer three main questions: Do dynamic chairs have a positive effect on students' behaviour compared with regular (non-dynamic) classroom chairs? How do dynamic chairs affect the movement of students in comparison to regular classroom chairs, and how is the movement related to students' behaviour? Do dynamic chairs have a positive effect on the academic achievement of students? This thesis comprises three distinct studies, each addressing one of the research questions.

In Study 1, I investigated whether BodyfurnFlex chairs affected students' on-task, disruptive, out-of-seat, and chair-tipping behaviours compared with regular classroom chairs by measuring and comparing behaviour across both seating conditions. I also examined whether BodyfurnFlex chairs affected student movement, measuring both in-chair and overall movement levels in the classroom. Additionally, environmental conditions (CO_2, temperature, and humidity) in the classrooms were monitored, and a survey was conducted to investigate students' perceptions of the chairs, including their preferences, whether they felt the chairs made it easier to complete their work, and the reasons for their responses.

In Study 2, I conducted an in-depth analysis of the movement and environmental data from Study 1. It provided a detailed overview of the Smart Classroom System, including data collection methods, and evaluated different aspects of the in-chair movement data (acceleration, rotation, and displacement). Additionally, Study 2 investigated whether BodyfurnFlex chairs could affect classroom noise levels and examined potential correlations between movement, environmental factors, noise, and behavioural variables.

Finally, in Study 3, I compared the impact of BodyfurnFlex and regular classroom chairs on students' academic achievement by tracking progress across several mathematics assessments.

Additionally, focus group discussions were held with students and teachers to gain deeper insights into their perceptions of the chairs and their impact on comfort and learning.

Chapter 2: Literature Review

Academic Achievement

Academic achievement, also known as academic performance, refers to outcomes that indicate the extent to which a person has accomplished academic goals/success, and is typically measured either by educational attainment (i.e., completion of a degree or qualification) or by test scores/grades (Nyström et al., 2019; Steinmayr et al., 2014; Wong et al., 2024). Academic achievement can have a significant positive effect on an individual's future quality of life, including better mental and physical health (Kosik et al., 2018; Lê-Scherban et al., 2014; Raghupathi & Raghupathi, 2020), increased life satisfaction (Lettau, 2021; Ng et al., 2015), improved well-being (Nordlander & Stensöta, 2014), higher income (Hahn & Chattopadhyay, 2019; Lallukka et al., 2019), greater self-esteem (Metsäpelto et al., 2020), and increased life expectancy (Kaplan et al., 2014; Raghupathi & Raghupathi, 2020). Better academic achievement also has several important societal benefits, including improved economic growth (Heller-Sahlgren & Jordahl, 2024; Woesserman, 2016), greater civic engagement (An et al., 2024; Belete, 2024), and lower crime rates (Lankester et al., 2025; Machin et al., 2011; Martins et al., 2022).

Academic achievement is influenced by a wide range of factors, both individual/personal and external/environmental (Costa et al., 2024; Nunes et al., 2023). Some of the most important personal variables include intelligence (Lozano-Blasco et al., 2022; Roth et al., 2015), personality type (Mammaddov, 2022; Meyer et al., 2023), attitude (Mao et al., 2022; Sölpük, 2017), motivation (Amrai et al., 2011; Kriegbaum et al., 2021), self-efficacy (Hwang et al., 2016; Motlagh et al., 2011), and study habits (Elango & Manimozhi, 2021; Walck-Shannon et al., 2021). While these individual variables are crucial in determining a student’s academic success, they can be difficult to change. However, there are many external variables that share a significant association with academic achievement and can be influenced, including teachers (López-Martin et al., 2023), parental involvement (Castro et al., 2015; Otani et al., 2020), the school and classroom climate (Dulay & Karadağ, 2017; Erdem & Kaya, 2024), socio-economic status (SES) (Liu et al., 2022; Selvitopu &

Kaya,2023), and the physical learning environment (Barrett et al., 2015; Cheryan et al., 2014; Opio et al., 2024). There are a number of aspects within the physical learning environment that have been shown to have a significant impact on the achievement of students, including the classroom design (Imms & Byers, 2017; Byers et al., 2018), lighting (Heschong et al., 2002; Mogas-Recalde & Palau, 2021), noise (Brill & Wang, 2021; Shield & Dockrell, 2008), and the environmental conditions, including CO_2, temperature, and humidity (Haverinen-Shaughnessy & Shaughnessy, 2015; Liu et al., 2021).

Environmental Variables in the Classroom

CO_2 is a colourless, odourless gas found in our atmosphere. When we exhale, we release CO_2 into the surrounding air. As a result, indoor spaces with large numbers of people, such as classrooms, often exhibit elevated CO_2 levels (López et al., 2023). CO_2 can significantly affect the learning environment and has been shown to decrease students' attention and cognitive function (Coley et al., 2007; Fan et al., 2023; Sidorin, 2015; Tu et al., 2021; Woo et al., 2022). According to Coley et al. (2007), in classrooms with high CO_2 levels, students are likely to be less attentive and struggle to focus on the teacher, with this decline in concentration comparable to the effect of skipping breakfast (Coley et al., 2007). Unsurprisingly, CO_2 has a significant negative association with students' academic performance (Haverinen-Shaughnessy & Shaughnessy, 2015; Haverinen-Shaughnessy et al., 2011; Wargocki et al., 2020). Additionally, CO_2 is linked to various negative health and social issues, including headaches, fatigue, agitation, feelings of depression, and lower attendance (Bogdanovica et al., 2020; Carrer et al., 2015; Gaihre et al., 2014; Settimo et al., 2024; Tu et al., 2021).

Classroom temperature also affects students' learning, with temperatures outside the range of 18-25 ˚C shown to significantly impair cognitive performance (Lan et al., 2022; Yeganeh et al., 2018), attention (Aydin & Goktas, 2023; Yeganeh et al., 2018), and academic outcomes (Cho, 2017; Haverinen-Shaughnessy & Shaughnessy, 2015; Wargocki et al., 2019). Additionally, low indoor temperatures significantly increase the risk of catching viruses and developing respiratory infections

(Jaakkola et al., 2014; Mäkinen et al., 2009), while higher temperatures are linked to fatigue, dizziness, headaches, nausea, and sleepiness (Bidassey-Manilal et al., 2025; Lala & Hagishima, 2023; Tu et al., 2021).

Humidity is the measure of moisture (water vapour) present in the air. The amount of water vapour that can be held in the air without condensation (i.e., turning to water) is dependent on the air temperature. As the temperature rises, the amount of moisture that can be in the air increases. Humidity is typically expressed as relative humidity, which refers to the percentage of water vapour in the air compared to the maximum amount of vapour that could exist at the current temperature. Both low and high humidity have been shown to significantly increase the risk of illness, including respiratory infections, asthma symptoms, and allergies (Angelon-Gaetz et al., 2016; Jaakkola et al., 2014; Mäkinen et al., 2009; Toyran et al., 2020). Humidity has also been shown to affect memory, cognitive performance, fatigue, attention, and academic performance (Liu et al., 2021; Qiu et al., 2021; Sarbu & Pacurar, 2015; Tian et al., 2021).

The New Zealand Ministry of Education has strict guidelines regarding the environmental conditions in classrooms to guarantee they are suitable for students' learning and health (Ministry of Education, 2022). It is recommended that the daily average CO_2 concentration in learning spaces be no greater than 800 ppm (parts per million); however, it is compulsory that the daily average does not exceed 1,250 ppm. Furthermore, CO_2 concentration must never surpass 2000 ppm at any time during the day. Classroom temperature should be maintained between 18-25 ˚C, while the relative humidity must always be within 35-70% (Ministry of Education, 2022).

Despite strict guidelines, research has shown that many New Zealand classrooms do not meet the required standards for learning environments (Building Research Association of New Zealand, 2019a, 2019b; National Institute of Water & Atmospheric Research, 2022; Wang, 2020). The Building Research Association of New Zealand (BRANZ) carried out a study on indoor air quality in classrooms across New Zealand, including Auckland, Wellington, Christchurch, Dunedin, and the Hawke's Bay region. The findings indicated that CO_2 levels in numerous classrooms significantly

exceeded acceptable limits, with one Christchurch classroom recording average CO_2 levels of 2000–3000 ppm over an entire week. Another classroom experienced levels above 2000 ppm for most of the year, reaching up to 3,800 ppm (more than three times the daily average limit). In Hawke's Bay and Dunedin, students faced temperatures below 16°C for extended periods, whereas a Christchurch classroom frequently recorded temperatures above 28°C (Building Research Association of New Zealand, 2019a, 2019b). The study also found that the weekly average humidity in one Christchurch classroom was 81%. Additionally, some Hawke's Bay classrooms had humidity levels often exceeding 70%, with one reaching 86%.

The findings of the Building Research Association of New Zealand (2019a, 2019b) suggest that many students in New Zealand are not receiving the quality of learning spaces required by the Ministry of Education. As a result, the learning and health of many New Zealand students are likely to suffer. It appears there is a need for tools/equipment that can accurately measure environmental variables and assess the quality of learning spaces, to identify which spaces require interventions (e.g., ventilation, air conditioning).

Furthermore, despite extensive research on the effects of CO_2, temperature, and humidity on students' attention, cognitive performance, and academic achievement, there is limited research on how these variables influence students' on-task behaviour, disruptive behaviour, and movement, underscoring the need to examine these relationships.

Noise in the Classroom

Another key factor that can significantly impact academic achievement is classroom noise (Buchari & Matondang, 2017; Caviola et al., 2021; Fernandes et al., 2019; Shield & Dockrell, 2008). In addition to negatively affecting their achievement, noisy classroom environments can harm the well-being of students (Astolfi et al., 2023; Mealings & Bucholz, 2025) and teachers (Kristiansen et al., 2011; Mealings et al., 2024). One study found that students reported that classroom noise made it difficult to hear the teacher, ask questions, focus, and caused them to feel stressed, uncomfortable, angry, dizzy, and less enthusiastic about attending class (Buchari & Matondang,

2017). Noise in the classroom can originate from a wide range of sources, including environmental (e.g., traffic, air conditioning, electrical noise or humming, weather) and behavioural (e.g., students talking) factors (Alqahtani et al., 2023; Rantala et al., 2015). Behavioural noise in the classroom is often viewed as a sign of disruptive behaviour (Douglas et al., 2016; Olota, 2022) and a lack of student engagement (Chapman et al., 2023; Ludyga et al., 2022). Therefore, there is reason to believe that if dynamic chairs can improve students' behaviour (i.e., increase engagement and reduce disruptive behaviours), they may also reduce classroom noise levels.

Student Perceptions

While objective measurement is important, students' perceptions and opinions can also impact their achievement. Higher satisfaction and better perceptions of the physical learning environment have been shown to have a significant positive effect on students' academic performance (Edgerton & McKechnie, 2023; Hopland & Nyhus, 2015; Opio et al., 2024; Salar et al., 2024). Student perceptions are not only important for determining whether educational practices/interventions are effective, but are also crucial for determining their acceptability and whether participants find them meaningful (Ferguson & Cihon, 2021; Huntington et al., 2023). This is important because even if learning interventions are effective, they are only useful if students are willing to use/implement them. Another significant implication of students' perceptions is their impact on student engagement, with improved perceptions of the physical learning environment shown to have a significant positive correlation with student engagement (Edgerton & McKechnie, 2023; Scott-Webber et al., 2018).

Student Engagement

Student engagement is a broad concept that has been defined in various ways; however, in simple terms, it refers to students being actively involved in their learning tasks and activities (Lei et al., 2018). Student engagement is multidimensional and comprises three key aspects: cognitive, emotional, and behavioural engagement (Lei et al., 2018; Wong et al., 2024). Cognitive engagement refers to the mental effort or investment put into learning, involving focusing one's attention and

concentration on the activity or task (Halverson & Graham, 2019; Reeve et al., 2025). Emotional (or affective) engagement refers to a student's emotional investment and feelings towards learning, including enthusiasm, motivation, interest, and attitude (Liu et al., 2024; Reeve et al., 2025). Meanwhile, behavioural engagement is the observable actions of students participating in learning activities and tasks (Cappella et al., 2013; Reeve et al., 2020).

Student engagement has been shown to have a significant positive correlation with academic achievement (Lei et al., 2018; Tao et al., 2022; Wong et al., 2024). Wong et al. (2024) conducted a comprehensive systematic review and meta-analysis, including 137 studies and 158,510 participants, on student engagement and its association with academic achievement. The results revealed a significant positive relationship between student engagement and academic achievement (r = .33, p < .001). However, when analysed in its three dimensions, behavioural engagement showed the strongest correlation with academic achievement (r = .39, p < .001), surpassing both cognitive (r = .31, p < .001) and emotional engagement (r = .26, p < .001). Another meta-analysis, involving 69 studies and 196,473 participants, yielded similar results (Lei et al., 2018). They found that academic achievement had a noticeably larger correlation with behavioural engagement (r = .35, p < .001) than with cognitive (r = .25, p < .001), emotional (r = .22, p < .001), or overall student engagement (r = .269, p < .001). These findings suggest that behavioural engagement is the best indicator of academic achievement, even more so than all the dimensions of student engagement combined (i.e., overall engagement). Furthermore, since behavioural engagement involves students' observable actions, it can be measured through direct observation. Conversely, cognitive and emotional engagement are internal and subjective, making them harder to measure and quantify.

Although the correlation between behavioural engagement and academic achievement is moderate in size, it remains one of the most influential factors when compared to other significant determinants of academic success. This includes intelligence (r = .37) (Lozano- Blasco et al., 2021), motivation (r = .27) (Kreigbaum et al., 2018), SES (r = .22) (Liu et al., 2022), teacher competence (r =

.40) (López- Martin et al., 2023), and school (*r* = .28) and classroom climate (*r* = .20) (Erdem & Kaya, 2024).

Behavioural engagement, often referred to as on-task behaviour (Caldarella et al., 2021; Philp & Duchesne, 2017; Schmidt et al., 2025), has important implications beyond academic achievement, including positive reciprocal relationships with students' subjective well-being (Wong et al., 2024; Zhu et al., 2019), self-esteem (Karababa, 2020; Eryılmaz & Kara, 2025), and teacher-student relationships (Engels et al., 2016). Low behavioural engagement is also a significant predictor of students dropping out of school (Archambault et al., 2022; Lamote et al., 2013; Szabó et al., 2024; Wang & Fredricks, 2014). Another important implication of on-task behaviour is its significant negative association with disruptive behaviour (Becherer et al., 2021; Bru, 2006; Caldarella et al., 2021).

Disruptive Behaviour

Disruptive behaviour is often functionally defined in classroom settings as behaviour on the part of the learner that interferes with the teacher's ability to teach or another student's ability to learn (Dobmeier & Moran, 2008; Meany-Walen et al., 2014). Common examples include speaking out of turn (i.e., talking when it's not appropriate or interrupting), disrupting or interfering with other students, fighting, or engaging in verbal or physical abuse or threats (Collins et al., 2016; Ødegård & Solberg, 2024). Disruptive behaviours can disturb other students, causing them to become off-task and negatively impacting the learning environment of the entire classroom (Alkhadim, 2024; Okeke et al., 2023).

Disruptive behaviour also has a significant negative effect on the academic achievement of not only the students who exhibit disruptive behaviours (Alatupa et al., 2011; Bierman et al., 2013; Finn et al., 1995; Flores-Mendoza et al., 2013; Kremer et al., 2016) but also the entire classroom (Bäckström, 2021; Blank & Shavit, 2016; Goulas et al., 2024; Kristoffersen et al., 2015; Zhao & Zhao, 2021). Flores-Mendoza et al. (2013) conducted a study examining how students' disruptive behaviour (N = 160), alongside factors such as SES, crystallised and fluid intelligence, and various

personality traits (including psychoticism, extroversion, and neuroticism), affected academic achievement. The findings indicated that student's disruptive behaviour had a significant negative correlation with their academic achievement (r = -.34, p < .01) and emerged as the second strongest predictor of achievement (β = −.28, SE = .08, p < .001), following crystallized intelligence (β = .40, SE = .08, p < .01). A separate study found that the disruptive behaviour of students (N = 1,013) had a significant (p < .01) negative effect on test scores in mathematics (r = -.29), language (r = -.28), reading (r = -.21), social studies (r = -.20), and science (r = -.18) (Finn et al., 1995). Blank and Shavit (2016) investigated the effect of disruptive behaviour on the test scores of 2,422 students, finding that disruptive behaviour in the classroom was negatively correlated with the mean achievement of the entire classroom (r = -.29, p < .01).

Students' disruptive behaviour can also have a significant negative effect on teachers' well-being and is associated with teacher burnout, exhaustion, and job dissatisfaction (Ghanizadeh & Jahedizadeh, 2015; Kollerová et al., 2023; Otero-López et al., 2009; van den Brink et al., 2025; Vidić et al., 2021). According to Kollerová et al. (2023), the current literature indicates that student disruptive behaviours are considered the primary social stressor that increases teaching demands and contributes to teacher exhaustion. Recent studies have found that many teachers are considering leaving the profession, with student behaviour among the leading causes (Doan et al., 2024; Reinke et al., 2025).

Two of the most common and problematic types of classroom disruptive behaviours are out-of-seat behaviour (Axup & Gersch, 2008; Infantino & Little, 2005; Patterson, 2009) and chair tipping (Cogswell et al., 2020; Ozdemir, 2008; Zuniga & Cividini-Motta, 2022).

Out-of-Seat Behaviour

Out-of-seat behaviour refers to a student leaving their seat without permission from the teacher and walking around the room during class (Conklin et al., 2017; Flower et al., 2014; Patterson, 2009). Out-of-seat behaviour is generally defined as anytime a student's

backside/buttocks lose contact with the seat of the chair (Matin Sadr et al., 2017; Sarver et al., 2015; Schilling & Schwartz, 2004).

Out-of-seat behaviour is consistently recognised as one of the most common and problematic disruptive behaviours by teachers (Alter et al., 2013; Atici & Merry, 2001; Axup & Gersch, 2008) and students (Infantino & Little, 2005; Patterson, 2009; Sun & Shek, 2012). Axup and Gersch (2008) asked teachers to identify three student behaviours that they found the most difficult to cope with. Out-of-seat behaviour was the third most prevalent response, following talking and general work avoidance, with 33% of all teachers surveyed identifying out-of-seat behaviour as one of the top three most difficult student behaviours to deal with. Infantino and Little (2005) surveyed 350 secondary school students and asked them to identify which behaviour they considered to be the most troublesome in the classroom. Out-of-seat behaviour was the third most common response, after talking out of turn and using inappropriate language.

Out-of-seat behaviour is also frequently identified as one of the most prevalent types of off-task behaviour in the classroom (Austin & Soeda, 2008; Godwin et al., 2016; Jaffal, 2019; Swinson & Knight, 2007). Swinson and Knight (2007) observed the type of behaviour exhibited by students (N = 303) when they were off-task (e.g., talking to other students, general inattention) and found that out-of-seat behaviour was the fourth most common type of off-task behaviour. Although out-of-seat behaviour is not always indicative of a student being off-task, unsurprisingly, several studies have demonstrated that when out-of-seat behaviour increases, time on-task decreases (Conklin et al., 2017; Fedewa & Erwin, 2011; Schilling & Schwartz, 2004).

Chair Tipping

Chair tipping, often referred to as students swinging or rocking in their chairs, is the act of using a foot, leg, or other body part to tilt the chair backwards, causing one or more legs to lift off the ground (Zuniga & Cividini-Motta, 2022). It is frequently listed as a common disruptive behaviour in classrooms (Cogswell et al., 2020; Miller, 2019; Ofsted, 2014; Ozdemir, 2008; Scattone et al., 2002; Zuniga & Cividini-Motta, 2022). A survey by the Office for Standards in Education, Children's Services

and Skills (Ofsted), which involved 1,048 teachers, identified chair tipping as one of the top 10 causes of classroom disruption (Ofsted, 2014). Besides being disruptive, chair tipping can also be dangerous, with chairs tipping over being a leading cause of injuries in classrooms (Goss, 1992; Salminen et al., 2014; van Dyne, 2010).

Interventions

A number of different interventions/strategies, including positive reinforcement (Crewdson et al., 2023; Kirkpatrick et al., 2019), self-management strategies (Bulla & Frieder, 2018; Smith et al., 2022), and social stories (Ozdemir, 2008; Scattone et al., 2002), are used to reduce disruptive behaviours such as chair tipping and out-of-seat behaviour. However, although effective at reducing disruptive behaviours, these are consequence-based interventions and do not necessarily address the underlying cause of the behaviour. As previously mentioned in the Education Review Office report, there is a need for interventions/strategies that address the underlying causes of disruptive behaviours, rather than just addressing the behaviour itself (Education Review Office, 2024). Behaviours such as chair tipping and out-of-seat behaviour are often attributed to attention-seeking or work avoidance (Mellor, 2005; Turtura et al., 2014). However, there is evidence suggesting that one reason students engage in these behaviours is pain/discomfort caused by static sitting (Antle et al., 2018; Knight & Noyes, 1999; Okino et al., 2022; Taylor et al., 2022; Udo et al., 1999).

Pain and Discomfort

Musculoskeletal pain/discomfort (related to the muscles, bones, ligaments, tendons, and nerves of the body) is a prevalent issue among students (Chambers et al., 2024; Gogoi et al., 2024; Kandasamy et al., 2024; Minghelli, 2020; Ogunlala et al., 2021). A meta-analysis conducted by Chambers et al. (2024) on the prevalence of chronic pain in children and adolescents, which included 119 studies and over a million children (age ≤ 19 years) from 70 different countries, showed that 1 in 4 children (25.7%, 95% CI [17.3-35.1]) suffer from chronic (persistent/recurring) musculoskeletal pain. Furthermore, musculoskeletal pain was found to be the most common type of chronic pain in

children, alongside headaches, which also had a prevalence of 25.7% (95% CI [22.2-29.3]) (Chambers et al., 2024).

A significant factor contributing to the high prevalence of musculoskeletal pain in students is static sitting (Caromano et al., 2015; Harithasan et al., 2022; Ogunlana et al., 2021; Waongenngarm et al., 2015; Zemp et al., 2016). Prolonged static sitting has been shown to significantly decrease circulation in the lower limbs, resulting in discomfort (Antle et al., 2018; Okino et al., 2022; Taylor et al., 2022). It is hypothesised that to relieve discomfort caused by static sitting, students will engage in fidgeting, which has been shown to significantly increase blood flow in the lower limbs (Morishima et al., 2016; Pettit-Mee et al., 2021; Tamiya et al., 2024). Fidgeting, which differs from active sitting, involves non-goal-oriented, repetitive movements (Carriere et al., 2013; Perrykkad & Hohwy, 2020), such as foot tapping, leg bouncing, pen clicking, or finger tapping (Carriere et al., 2013; Perrykkad & Hohwy, 2020). It is also a common disruptive behaviour in the classroom (Cogswell et al., 2020; See, 2012).

Similarly, tipping/rocking on a chair has been shown to increase blood flow in the lower limbs (Frey et al., 2021; Stranden, 2000; Udo et al., 1999), as has standing up or walking (Antle et al., 2018; Francisco et al., 2022). Knight and Noyes (1999) investigated the effect of school chairs on the behaviour of a classroom of primary school students (*N* = 21). In response to questions about what they did when they felt uncomfortable, 67% of participants reported rocking or tipping in their chairs. Furthermore, 48% of participants reported that, at some point, they had left their seat (i.e., out-of-seat behaviour) in response to discomfort (Knight & Noyes, 1999). Another study found that chair tipping significantly reduced neck, shoulder, and back pain, but increased hip pain (Udo et al., 1999). Although these two studies (Knight & Noves, 1999; Udo et al., 1999) suggest a connection between static sitting and behaviours like chair tipping or out-of-seat behaviour, the existing research on these behaviours and their link to pain/discomfort remains limited, highlighting the need for additional studies in this area.

Pain has also been shown to have a disrupting effect on attention (Attridge et a., 2017; Dick & Rashiq, 2007; Moore et al., 2012; Moore et al., 2019; Oosterman et al., 2012) and can have a significant negative impact on academic achievement (Grimby-Ekman et al., 2018; Kosola et al., 2017; Ragnarsson et al., 2022; Voerman et al., 2017). Conversely, physical comfort has been shown to improve student engagement (Aga, 2024; Hanaysha et al., 2023; Scott-Webber et al., 2018) and performance (Bell et al., 2005; Hoque & Weil, 2016). Additionally, pain is also associated with aggression and behavioural problems (Just et al., 2003; Lindley, 2012), reduced school attendance (Groenewald et al., 2019; Owiredua et al., 2023) and poor social functioning and peer relationships (Forgeron et al., 2010; Serbic et al., 2023).

Movement Interventions

One way schools have sought to reduce static sitting and improve student behaviour and achievement is by integrating movement into the classroom. Most commonly, this has been implemented through movement/physical activity breaks (short breaks in the lesson that involve physical activity) (Gilmore et al., 2024; Turner & Chaloupka, 2017). Gilmore et al. (2024) found that over 70% of teachers (N = 220) incorporate movement breaks into their classrooms, while another study reported that movement breaks are used in 76.5% of primary schools (N = 640) (Turner & Chaloupka, 2017).

Movement breaks have been shown to significantly increase students' on-task behaviour (Broad et al., 2023; Fenesi et al., 2018; Howie et al., 2014; Ma et al., 2014; Mavilidi et al., 2020; Watson et al., 2017; Webster et al., 2015). Watson et al (2017) conducted a meta-analysis of 39 studies on the effects of physical activity breaks on student behaviour and achievement. They found that physical activity breaks had a moderate positive effect on on-task behaviour and a moderate negative effect on off-task behaviour (d = 0.60, 95% CI: [0.20, 1.00]). Broad et al. (2023) found that movement breaks significantly ($p < .01$) increased students' on-task behaviour, regardless of whether the break was implemented in the morning (Δ 10.4%), afternoon (Δ 10.5%), or both (Δ 14%). Movement breaks have also been shown to decrease disruptive behaviours (Broad et al.,

2023; Chesnais et al., 2022; McGowan et al., 2021; Moon et al., 2022), including out-of-seat behaviour (Camahalan & Ipock, 2015; Wells, 2012). One study, which included 229 students from 12 different classrooms, found that movement breaks had a significant negative correlation with disruptive behaviour (r = -.26, p < .05) (Moon et al., 2022).

Movement breaks can also positively impact students' academic achievement (Donnelly & Lambourne, 2011; Fenesi et al., 2018; Mavilidi et al., 2020; Mullender-Wijnsma et al., 2015; Petrigna et al., 2022; Shoval et al., 2018; Watson et al., 2017). The meta-analysis by Watson et al. (2017) found that physical activity breaks had a large positive effect on academic achievement (d = 1.03, 95% CI: [0.22, 1.84]) when progress-monitoring tools were used. However, when standardised testing was used, there was generally no improvement in academic achievement (d = −0.13, 95% CI [-0.72, 0.46]). Despite their positive influence on students' behaviour and achievement, movement breaks interrupt lessons (cutting into valuable learning time) and require teachers to be trained on how and when to introduce them (Goh et al., 2018; Kerpan et al., 2019; Mahar, 2011).

Dynamic Seating

Another way that schools have looked to integrate movement into the classroom is through dynamic seating. Dynamic seating refers to alternative seating options designed to promote movement and encourage active sitting (Hyeong et al., 2014). Active (or dynamic) sitting involves maintaining consistent movement while seated through postural adjustments (Akkarakittichoke et al., 2023; Arippa et al., 2022; Hyeong et al., 2014). Dynamic seating is a broad term that encompasses a variety of options, including stability balls (also known as Swiss, therapy, or exercise balls), cycle chairs (chairs equipped with pedals so students can cycle while seated), wobble stools, and air cushions (inflatable cushions placed on regular chairs to encourage active sitting) (Rollo et al., 2019).

One type of dynamic seating that has been studied quite extensively is stability balls. Numerous studies have shown that, compared to regular classroom chairs, stability balls can significantly improve students' on-task behaviour and reduce some disruptive behaviours, including

out-of-seat behaviour (Brennan & Crosland, 2021; Fedewa & Erwin, 2011; Krombach & Miltenberger, 2020; Matin Sadr et al., 2017; Schilling, 2003; Schilling & Schwartz, 2004). However, all these studies only involved participants with either Autism Spectrum Disorder (ASD) or Attention Deficit Hyperactivity Disorder (ADHD). When used in mainstream classrooms, stability balls had either no effect on students' on-task behaviour and, in some cases, decreased it (Erwin et al., 2016; Fedewa et al., 2015; Hulac et al., 2020; Metz et al., 2020).

Research on the effects of other types of dynamic seating on student behaviour is limited, particularly in mainstream classrooms (Rollo et al., 2019). Outside of stability balls, the only other dynamic seating option tested in mainstream classroom settings is the cycle chair, which has been shown to have a significant negative effect on students' on-task behaviour (Fedewa et al., 2024). Furthermore, neither stability balls nor cycle chairs have been shown to positively affect students' academic achievement (Fedewa et al., 2015; Joubert et al., 2017; Mead et al., 2016; Torbeyns et al., 2017). The inability of stability balls and cycle chairs to have a positive effect on students' behaviour or achievement in mainstream classroom settings may be due to their failure to reduce static sitting. Erwin et al. (2016) found that stability balls actually reduce student movement in comparison to regular classroom chairs. Meanwhile, although cycle chairs have been shown to increase energy expenditure and heart rate (Fedewa et al., 2017; Torbeyns et al., 2017), there is no evidence that they can reduce static sitting (i.e., sitting in the same posture).

Rollo et al. (2019) conducted a systematic review on the effects of dynamic seating on students' behaviour and achievement. They concluded that dynamic seating could positively influence the behaviour of students with ASD and ADHD. However, there was no clear evidence that it could improve the behaviour or academic achievement of general-education students. Furthermore, they emphasised that more rigorous and in-depth research is needed into the effects of dynamic seating, outside of stability balls and cycle chairs (Rollo et al., 2019).

Dynamic Chairs

Although dynamic chairs are a type of dynamic seating, they are not directly comparable to other dynamic seating options, such as stability balls. A dynamic chair is a chair (a specific type of seat that includes a flat or slightly angled seat, one or more legs, and a backrest) that incorporates dynamic features (i.e., features that allow movement). According to Hyeong et al. (2014), a dynamic chair features a flexible/dynamic backrest and seat panels that move with the user, enabling changes in posture (i.e., active sitting). There is reason to believe that, unlike other dynamic seating options, dynamic chairs could significantly improve the behaviour and achievement of mainstream students by increasing their movement and enhancing their comfort.

In contrast to stability balls and cycle chairs, a number of studies show that dynamic chairs can significantly increase the movement of occupants in comparison to static (non-dynamic) chairs (Garcia et al., 2016; Grooten et al., 2017; Nüesch et al., 2018; Stanić et al., 2022; Synnott et al., 2017; Tanoue et al., 2016). However, it should be noted that there are some limitations around the generalisability of the findings of these studies. Firstly, several of the cited studies included only adult participants and were conducted in isolated office or laboratory settings rather than classrooms (Grooten et al., 2017; Nüesch et al., 2018; Synnott et al., 2017; Tanoue et al., 2016). Garcia et al. (2016), on the other hand, examined how dynamic and static chairs affected the movement of 12 school-aged children (average age 8.3 years). Accelerometers were used to measure participants' movement, and a movement index (activity count, AC) was calculated to compare their relative activity levels. Two test sessions were conducted, each consisting of a 20-minute lecture. A within-subjects design was implemented, with half of the participants (n = 6) assigned to the dynamic chair condition and the other half (n = 6) to the static chair condition. After the first session concluded, they switched conditions for the second session. The results showed that participants moved significantly more when seated in the dynamic chairs compared to the static chairs (40.82 AC/min vs. 9.81 AC/min, $p < .01$). However, this study had several limitations, including taking place in an exercise physiology laboratory (not directly comparable to a regular classroom

setting), there was limited information about the chairs used in the study, no details were provided on how the movement index was calculated, and all data was collected over a very short period within a single day (two 20-minute sessions with a 5-minute break in between) (Garcia et al., 2016).

Stanić et al. (2022) also used accelerometers to compare the effects of three types of seating (traditional school chair, stability balls, and a dynamic chair) on children's movement (N = 23, aged 8-11 years). The results showed that participants moved significantly more when seated in the dynamic chair compared to the stability ball, $F(1, 21) = 5.06$, $p < .05$, $\eta 2p = .19$, and the traditional school chair, $F(1, 21) = 15.49$, $p < .01$, $\eta 2p = .43$. However, this study also had some limitations, including assessing participants one by one in a counselling room instead of a classroom group setting. But most importantly, they did not specify how much time participants spent in each seat (Stanić et al., 2022).

Dynamic chairs have also been shown to reduce users' pain and discomfort compared with static (non-dynamic) chairs (Cardenas et al., 2024; Cardoso et al., 2021; Frey et al., 2021; Garcia et al., 2016; O'Keeffe et al., 2013; Tanoue et al., 2016). However, as with movement, most of these studies were conducted in office settings with adult participants (Cardenas et al., 2024; Cardoso et al., 2021; Frey et al., 2021; O'Keeffe et al., 2013; Tanoue et al., 2016). Garcia et al. (2016), who, as previously discussed, compared the effects of dynamic and static chairs on children's movement, also asked participants for their opinions on the chairs. The participants reported that the dynamic chairs were more comfortable than static chairs. However, it is unclear how many participants reported that the dynamic chairs were more comfortable (Garcia et al., 2016).

The current literature also suggests that, compared with static chairs, students have more positive perceptions of dynamic chairs (Garcia et al., 2016; Stanić et al., 2022). Garcia et al. (2016) found that 75% of participants (N = 12) reported that they would prefer sitting on the dynamic chairs over the static chairs at school, stating that they were 'more fun' and comfortable. One participant reported feeling more alert and attentive while sitting in the dynamic chair (Garcia et al., 2016).

Similarly, Stanić et al. (2022) found that 75% of participants (*N* = 24) preferred the dynamic chair over the stability ball (16.7%) and the regular chair (8.3%).

In summary, the reviewed literature suggests that dynamic chairs could improve students' behaviour and achievement by increasing student movement and improving their comfort and perceptions, all of which are associated with improved behavioural and academic outcomes (Aga, 2025; Broad et al., 2023; Edgerton & McKechnie, 2023; Grimby-Ekman et al., 2018; Mavilidi et al., 2020; Salar et al., 2024; Watson et al., 2017). However, more robust research is needed into the effects of dynamic chairs on students' movement, comfort, and perceptions, particularly in a classroom setting where students can experience the chairs over an extended period.

Despite the current literature suggesting that dynamic chairs could improve students' behaviour and achievement compared to regular classroom chairs, there remains a distinct lack of research specifically examining their impact on these outcomes. However, in 2021, a master's research project sought to address this gap in the literature by evaluating the effect of a dynamic chair, called the Bodyfurn chair, on students' on-task and disruptive behaviour compared with regular classroom chairs (Martin, 2021). The study included three separate groups of five primary school students and used a multiple baseline design. All three groups used regular classroom chairs during the baseline phase, and Bodyfurn chairs were introduced in a staggered fashion once stable baselines were established. The results showed that the introduction of Bodyfurn chairs resulted in immediate and noticeable increases in on-task behaviour in two of the three groups, with a ceiling effect preventing any noticeable experimental effect from occurring in the third group. The results also showed marked decreases in disruptive behaviour across all three groups when Bodyfurn chairs were used, compared to the regular classroom chairs. When asked for their opinions on the chairs, 13 of the 15 participants reported that they preferred the Bodyfurn chairs over the regular chairs, stating that they were more comfortable, reduced back pain, and allowed them to adjust their position easily (Martin, 2021). The findings of this study suggest that, compared to regular classroom chairs, dynamic chairs can improve students' on-task behaviour and comfort while reducing pain and

disruptive behaviours, and in turn may be able to improve their academic achievement (Martin, 2021). However, the study had several limitations that impacted the validity and generalisability of the results. These included ceiling and floor effects, the inclusion of only one age group and one type of regular chair (limiting the external validity of the findings), and the study being conducted in small breakout rooms with just five students (which is not comparable to a typical classroom environment).

Chapter 3: Methodology

Since each study in this thesis is presented as a manuscript for journal submission, word limit restrictions and specific structural requirements imposed by journals limit the amount of information about each study's methodology that can be included. The purpose of this chapter is to provide a more comprehensive and detailed account of the methodology used in this research, including: the rationale for its inclusion, the research approach and underpinning theoretical framework, ethical considerations and how they were addressed, and additional details that could not be included in the manuscripts. Because the data for studies 1 and 2 were collected simultaneously and involved the same participants, much of their methodology is outlined together.

Research Approach

The current research comprises three distinct studies, each building upon the findings of the previous. In Study 1, I investigated the effect of BodyfurnFlex chairs on students' behaviour and movement, monitored classroom environmental conditions, and collected social validity data using a survey. In Study 2, a detailed analysis of the movement and environmental data collected during Study 1 was conducted, including an investigation of potential associations among the movement, environmental, and behavioural variables. In Study 3, I explored whether the BodyfurnFlex chairs had a positive effect on students' academic achievement compared with regular classroom chairs and conducted focus group discussions to gain a deeper understanding of teachers' and students' perceptions of the chairs.

These studies were approached from a positivist perspective. Positivism is a theoretical framework that asserts that knowledge is only valid if it is based on observable, measurable facts (i.e., empiricism) obtained through the scientific method, and rejects abstract, unobservable concepts (e.g., subjective internal states) as valid forms of knowledge because they are unobservable and unverifiable (Park et al., 2020). A positivist approach has been adopted in various fields, including psychology and the social sciences, as exemplified by behaviourism. Behaviourism is the philosophy of the science of behaviour, focusing on observable, measurable behaviours rather

than internal mental states (e.g., emotions, motivations, attitudes). It asserts that all behaviours are shaped by environmental interactions/stimuli (i.e., conditioning) and focuses on the relationships between the observable behaviours and the physical or social environment (Cooper et al., 2020, pp. 22-30). The practical application of the principles of behaviourism is called applied behaviour analysis (ABA), which can be defined as the science of understanding and improving socially significant behaviours, using objective measurement and experimentation to assess and identify practical interventions that can reliably influence behaviour (Cooper et al., 2020, pp. 18, 34).

Using an ABA approach in these studies was appropriate and beneficial for several reasons. Firstly, ABA focuses on the objective measurement of directly observable behaviour rather than on subjective internal states, such as attitudes or motivation, or hypothetical constructs, such as intelligence. This is crucial for removing bias in both the researcher and participants (i.e., self-reported data) and for producing objective, reliable data (Cooper et al., 2020, pp. 86-91). Given that the current research is an evaluation of these chairs and their potential benefits, producing objective, unbiased data is crucial.

Secondly, ABA research focuses on socially significant behaviours, meaning that improvements in the target behaviour must have a meaningful impact that benefits the participant (e.g., comfort, safety, academic outcomes) or others around them (e.g., teachers, parents, peers) (Cooper et al., 2020, p. 31). This is important because while dynamic chairs could affect many factors, if they do not translate into real-life, socially significant outcomes, the results are essentially meaningless.

Thirdly, a key focus of ABA is conducting experiments to identify and clarify functional relationships between interventions and socially significant behaviours. This is demonstrated when a well-controlled experiment shows that a specific change in the behaviour is reliably produced by manipulating the independent variable (in this case, chairs), and that the change is unlikely to be due to extraneous variables (Cooper et al., 2020, pp. 19-20). Demonstrating a functional relationship is

crucial to show that an intervention can reliably influence socially significant behaviours and, in turn, improve participants' lives.

Finally, ABA primarily uses single-case research designs (SCRDs) to identify and analyse functional relationships. SCRDs are an experimental method that focuses on a single case (either an individual or a small group of individuals), with the case serving as its own control by repeatedly measuring the target behaviour (or behaviours) as they are exposed to each condition (e.g., the presence and absence of the intervention) (Cooper et al., 2020, p. 185). SCRDs not only allow you to analyse the effectiveness of a treatment without requiring a large number of participants, but also provide strong internal validity when well controlled (Cooper et al., 2020, p. 182).

Ethics

The ethical standards and principles guiding this research were based on the Code of Ethics for Psychologists working in Aotearoa/New Zealand (New Zealand Psychological Society, 2012), the Behaviour Analyst Certification Board's Professional and Ethical Compliance Code for Behaviour Analysts (Behavior Analyst Certification Board, 2020), the New Zealand National Ethics Advisory Committee (NEAC) National Ethics Standards (National Ethics Advisory Committee, 2025), and the University of Waikato Ethical Conduct in Human Research and Related Activities Regulations (The University of Waikato, n.d.-a). Ethical approval was obtained from the University of Waikato Division of Arts, Law, Psychology and Social Sciences (ALPSS) Human Research Ethics Committee (The University of Waikato, n.d.-b) prior to data collection for Studies 1 and 2 (Appendix A) and Study 3 (Appendix B). Several key ethical issues were considered, including participant consent, potential disruption to classroom learning, data confidentiality, the use of video cameras, and potential conflicts of interest.

Consent

The current research included participants under the age of 16, the age of consent in New Zealand, meaning they could not legally provide informed consent to participate. This was addressed

by obtaining consent from a parent or legal guardian on their behalf. Additionally, assent (expression of approval or agreement) was also collected from the student participants.

Informed consent/assent was obtained by providing participants and their parents/guardians with detailed information about the research and adequate opportunities to ask questions. Participants and their parents/guardians could withdraw consent/assent and data (where possible) at any time during the studies. Additionally, passive consent (i.e., consent is assumed unless the participant opts out) was obtained from some participants and their parents/guardians in this research. Passive consent is often appropriate for low-risk studies (i.e., where the probability and magnitude of anticipated harm/discomfort are not greater than those normally experienced), provided that participants are adequately informed about the study and given a sufficient opportunity to opt out (National Ethics Committee, 2021). The specific procedures for obtaining consent in each study are outlined in the Participant Recruitment section (pp. 31-33).

Disruption to Learning

Another key ethical consideration was the potential for the current research to disrupt classroom learning. In addition to obtaining the principals' permission to conduct the studies at the schools, steps were taken during the design and implementation of the research, including consultation with teachers and school leadership, to minimise disruption to classroom learning. The specific instances and steps taken to ensure this are detailed throughout this chapter under the relevant section.

All observational equipment (video camera and sensors) used in Studies 1 and 2 was strategically positioned out of the way to prevent interference with teaching or student learning. The only other variable altered/influenced in the current research was the chairs. All other variables of the learning environment (both physical and social) remained unchanged, as they would have been if the research had not taken place.

Confidentiality and Anonymity

All data were kept confidential and reported anonymously to protect the identities of participating schools, teachers, and students. While the age level and region (e.g., the Bay of Plenty, New Zealand) of the participating schools were reported, no names or other identifiable information were included in the results or anywhere else. All data were reported at the group level, meaning that no individuals were identifiable in the results. Additionally, whenever possible, data were collected anonymously, including overall classroom movement, participant surveys, and test grades. No personal information was collected from participants (apart from names on consent forms) as part of the current research. Signed consent forms were stored in a secure location at the University of Waikato, accessible only to my supervisors and me. These documents will be destroyed five years after the completion of the research project, in accordance with the ALPSS Ethics Committee's requirement that all data be retained for at least five years following the project's conclusion.

Video Cameras

Studies 1 and 2 used video cameras to remotely observe student behaviour. In addition to obtaining informed consent from participants who would be on camera, it was also important that participants who did not give assent/consent could easily avoid being filmed without disrupting their learning (e.g., without impeding their ability to walk across the room to fetch a pair of scissors). This was achieved by placing the camera against a wall on the side of the room and focusing only on the tables of students who had consented to be filmed. These tables were located on the far side of the room, allowing other students to remain out of the camera's view.

To ensure privacy, video recordings were immediately transferred to a password-protected computer after the data collection session and subsequently deleted from the camera. Video files were backed up on the University OneDrive and will be permanently deleted five years after the research project concludes.

Conflict of Interest

Because the current research received support from the designers/owners of the BodyfurnFlex chairs (Furnware), this posed a potential conflict of interest, requiring steps to ensure it did not influence the results. Although Resero/Furnware supplied the BodyfurnFlex chairs and Smart Classroom System, all other funding, including the student stipend and university host fee, was provided by a third party (Callaghan Innovation) as part of an R&D Grant. Neither the university nor I received any payment or compensation from Resero/Furnware. Furthermore, as outlined in the Callaghan Innovation funding agreement (contract number: FURNW2102), the university and researcher retain the right to publish any findings in research papers and/or the student's thesis. Resero/Furnware were not involved in the design of the studies, data analysis, or interpretation of the findings.

Participants

The target population in this research was school-aged students (Years 1-13) in New Zealand. In all three studies, teachers were indirect participants (individuals whose welfare, rights, or environment are affected by the study but who are not directly intervened upon or providing data). However, in Study 3, several teachers also participated directly in focus group discussions.

School Selection

In **Studies 1 and 2**, it was important to establish stable, consistent learning environments to enable accurate and reliable data collection. To achieve this, several criteria were used to select schools to approach for participation: schools with single-cell classrooms, traditional classroom layouts, and a consistent teaching schedule.

Including traditional single-cell classrooms was considered important for minimising distractions. Many New Zealand schools have larger open-plan classrooms that contain multiple classes (Bradbeer et al., 2017; Fletcher & Everatt, 2021; Stewart et al., 2024), but these were unsuitable for this research because neighbouring classes can cause disruptions (Ito & Yokoyama, 2019; Mealings et al., 2015; Shield et al., 2010), acting as a potential confounding variable.

Secondly, it was important to select schools with classrooms featuring consistent seating options and layouts. Innovative learning environments (ILEs) that offer a range of seating arrangements/options (e.g., allowing students to move around the room and select from numerous seating options and positions) are becoming increasingly popular (Attai et al., 2021; Putman et al., 2024). However, given that seating layouts can have a significant effect on student behaviour (Byers et al., 2018; Imms & Byers, 2017; Nja et al., 2023), the classroom layout needed to remain consistent throughout data collection to control for this potential confounding variable. Furthermore, it was crucial that all students used the same type of chair to ensure experimental control.

Thirdly, it was important to have classes that followed a regular schedule and timetable (e.g., math class 9 am-10 am), which would allow for consistent data collection (i.e., same subject and class times).

Finding schools that met these criteria was important because, although classrooms can be adapted to meet them, such adjustments can cause considerable disruption to learning and/or require substantial effort and time from teachers. I contacted several schools in the Bay of Plenty region by email to gauge interest in participating in the study. Subsequently, I met with the principals of various schools to discuss the project in more detail, determine which schools would be the best fit for participation based on the selection criteria, and assess their interest in participating.

Study 3 used the same selection criteria to identify potential schools but narrowed the scope to exclude senior high school students (Years 11-13) who undergo National Certificate of Educational Achievement (NCEA) testing (New Zealand Qualifications Authority, n.d.). NCEA's four-level grading system (Not Achieved, Achieved, Merit, and Excellence) is less sensitive to small achievement changes than the testing used for other New Zealand age groups, which uses a 14-level system with sublevels (Ministry of Education, n.d.-a), making it more sensitive and better suited for detecting changes.

Participant Selection

Studies 1 and 2. After selecting schools for participation, several classes meeting the three selection criteria at each school were considered for the study. The selected classes were considered the best choice because both teachers and students showed enthusiasm for participating (reducing the risk of attrition), and the classrooms had the most suitable layouts for conducting the research, including appropriate locations for placing observation equipment.

While overall movement and social validity data were collected for all students, in-chair movement and behaviour data were gathered from only 10 students per class. This was because collecting behavioural data for the entire classroom was impractical, and the Smart Classroom System had enough sensors to record the in-chair movement of only 10 students. The 10 students were selected as a representative sample of the classroom using purposive sampling.

Study 3. After selecting the school, I consulted with school leadership and several department heads to identify the most appropriate student group for the study. It was ultimately decided that the Year 9 maths cohort would be the best choice because their curriculum involved regular testing and retesting of the same subjects later in the year, enabling the collection of baseline data and the assessment of academic progress.

Participant Recruitment

Studies 1 and 2. Separate information sheets and consent/assent forms were provided to teachers (Appendix C), the 10 selected students (Appendix D) and their parents/guardians (Appendix E), and all other students (Appendix F) and their parents/guardians (Appendix G). The information sheets explained the purpose of the study, what data would be collected, their role in the study, the study timeline, where results would be published, data confidentiality, the right to withdraw at any time and how to do so, along with contact details of myself, my supervising professor, and the ethics committee. Additionally, I met with both participant groups (teachers and students) before the study to explain the project and answer any questions. It should also be noted that while the information sheets given to the selected students (Appendix D) and their parents/guardians (Appendix E) stated

that their behaviour would be observed, it was not specified which behaviours would be assessed, to prevent any potential influence on their behaviour.

The 10 selected students and their parents/guardians received active assent/consent forms that both needed to be signed and returned to me before participating in the study. Meanwhile, all other students and their parents/guardians received passive assent/consent forms, which allowed them to opt out or withhold consent. Passive consent was appropriate for the 'other' students in this study for several reasons: they were not recorded on video, no personal information was collected or shared, overall movement data was collected anonymously and at the group level, the student surveys were anonymous and voluntary, and the study caused minimal disruption or interference with students' learning. No students or their parents/guardians withheld consent to participate in this study.

Study 3. Information sheets and passive assent/consent forms were provided to all teachers (Appendix H), students (Appendix I), and their parents/guardians (Appendix J). The information sheets explained what the study was about, what data would be collected, where and how data would be reported, data anonymity and confidentiality, the right to withdraw their data from the study up to three weeks after the final test and how to do so, and the contact details of myself, my supervising professor, and the ethics committee.

Passive assent/consent was considered appropriate in this study for several reasons: no personal information was collected, all data were anonymised before being shared with me and reported at the group level, and the study did not involve any changes to the learning or assessment procedures (all students were required to learn the subject material and sit these tests as part of the course curriculum regardless of their participation in the study).

Additional information sheets and active consent/assent forms were provided to teachers (Appendix K), students (Appendix L), and parents and guardians of students (Appendix M) who participated in the focus group discussions. These included details on what the focus groups were about, how they would be conducted, what questions would be asked, how the discussions would

be recorded and transcribed, data anonymity and confidentiality, the right to withdraw from the discussion at any time, where and how data would be published, and the contact details of myself, my supervising professor, and the ethics committee. Signed assent/consent was required from both students and their parents/guardians for any student to participate in the focus group discussions.

Materials

Chairs

The current research included two types of chairs: regular non-dynamic classroom chairs (baseline/control) and dynamic classroom chairs (intervention).

The Dynamic Classroom Chairs were the BodyfurnFlex chairs (Furnware, n.d.-a), supplied by the project stakeholders, Furnware. Chair sizes were determined by students' age groups and table/desk heights (Furnware, n.d.-c).

The **Non-Dynamic Classroom Chairs** were standard monobloc plastic school chairs. In Studies 1 and 2, different brands of non-dynamic chairs were used for each group (participating classroom) to enhance the generalisability of the findings. The schools provided regular classroom chairs, which I measured before data collection to confirm they were the correct height/size for the table/desk height and age groups in each classroom.

In Study 3, all classrooms used the same brand of regular, non-dynamic classroom chair. This was important because Study 3 used a pre-post intervention, between-groups design, making it essential that both groups (control and intervention) used the same regular chair during baseline data collection.

Smart Classroom System

The Smart Classroom System is a network of sensors that monitor various environmental factors and types of movement. Funded by Resero and developed by Callaghan Innovation engineers, the system features timestamped raw data, which is essential for accurate data analysis of specific time periods. While the sensors are publicly available, software that can integrate them

with timestamped data is not, making the Smart Classroom System uniquely suited for the current research.

Video Camera

Behavioural data collected in Studies 1 and 2 were gathered remotely through video recordings. Using remote collection allowed for a more authentic replication of the usual classroom environment, as having a researcher physically present could influence or alter students' and teachers' behaviour. Additionally, observing all 10 students' behaviour simultaneously in person is impossible for a single researcher to do accurately. Therefore, recordings of the sessions enabled the simultaneous monitoring of all 10 students' behaviour. It also allowed me to rewind footage and carefully examine behaviour, as in some cases it can be difficult to initially judge whether a behaviour was present. Additionally, having video recordings facilitated the collection of interobserver agreement (IOA) data.

Despite the benefits, collecting behavioural data remotely has a key limitation: students going off camera, which prevents their behaviour from being observed. However, steps were taken to ensure accurate measurement, including removing intervals when students were off-camera. After careful consideration of these factors, it was concluded that the benefits of collecting behavioural data remotely outweigh this limitation.

Behaviour Data Coding Sheets

I created coding/scoring sheets to record behavioural data in Study 1. There were four data coding sheets, one for each target behaviour: on-task behaviour (Appendix N), disruptive behaviour (Appendix O), out-of-seat behaviour (Appendix P), and chair tipping (Appendix Q). Sheets were completed and stored digitally on the laptop.

Assessments

In Study 3, students were assessed using the New Zealand Curriculum level grading system (Ministry of Education, n.d.-b), as required by the Ministry of Education for all state schools in New Zealand (Te Kete Ipurangi, 2009). Testing was conducted using e-asTTle (Ministry of Education, n.d.-

a), an online assessment tool that assigns students a grade based on their level (1-10) and sub-level (Basic, Proficient, and Advanced). However, this grading system had a limitation: level or letter grading systems tend to be less effective than other testing methods, such as percentage-based or progress-monitoring tools, for detecting an experimental effect (Watson et al., 2017). Although collecting alternative test data (e.g., percentage-based testing) was considered, it would have caused significant disruption to scheduling (requiring additional time to implement these tests, thereby reducing valuable learning time) and increased teachers' workload in developing these new assessments. For these reasons, it was deemed impractical and unethical to pursue collecting alternative test data.

Participant Survey

An anonymous survey was used in Study 1 to gather social validity data for several reasons. Firstly, surveys are easy to distribute to large groups, allowing us to efficiently collect feedback from all participants. Secondly, surveys enable anonymous feedback, which encourages participants to give honest responses without fear of judgment (Leif et al., 2024; Murdoch et al., 2014). Finally, using standardised questions ensures that all respondents are asked the same questions in the same way, reducing the risk of moderator or group bias associated with other, more flexible methods such as interviews/discussions (Leif et al., 2024; Nyumba et al., 2018).

Focus Groups

Alongside my supervisors, I designed the prompt questions used in Study 3 focus groups to be open-ended, unbiased, focus on research aims, progress from general to specific, and encourage detailed, qualitative feedback (Ali et al., 2024; Ayala & Elder, 2011; Jowsey et al., 2021). Focus groups in Study 3 aimed to build on the social validity data gathered in Study 1. While surveys offer several key advantages, focus groups generally are a better approach for collecting in-depth, nuanced qualitative data (Chand, 2025; Cyr, 2017). Standardised survey questions can restrict expression and fail to capture the complexity and context of participants' experiences and feedback. Additionally, there is no opportunity for a researcher to probe further or seek clarification if a

response is vague. Furthermore, the open-ended nature of focus group discussions allows the collection of information that is not predetermined (i.e., the generation of themes and responses that you might not have anticipated).

Additionally, focus group discussions were also conducted with teachers, who were not surveyed in Study 1. This was considered important because even if learning interventions are effective, they are only useful if teachers are willing to implement them.

Procedure

Design

Studies 1 and 2 used a multiple-baseline with ABAB reversal design. The multiple baseline design is the most widely used experimental design for evaluating treatment effects in ABA and involves introducing the intervention in a staggered fashion across different behaviours, settings, and/or subjects (or groups) once stable baselines have been established (Cooper et al., 2020, pp. 223-230). The staggered introduction of the intervention allows for strong experimental control over extraneous factors such as history effects and participant maturation, providing strong internal validity for any potential experimental effects identified (Cooper et al., 2020, pp. 223-230). Furthermore, including different groups and settings (as in the current research) also improves the external validity (generalisability) of the results.

The ABAB reversal design is considered the most powerful SCRD for demonstrating functional relationships and involves alternating between baseline (e.g., regular chairs) and intervention (e.g., BodyfurnFlex chairs) conditions (Cooper et al., 2020, p. 199). The primary advantage of the ABAB reversal design is its ability to clearly demonstrate a functional relationship between the intervention and a behaviour, while controlling for other variables. When an experiment demonstrates that a target behaviour can be reliably influenced by presenting and withdrawing an intervention multiple times, it allows a clear demonstration of a functional relationship (Cooper et al., 2020, p. 206).

Combining multiple baseline and ABAB reversal designs greatly strengthens the internal validity of the results (more than using either design alone).

Study 3 used a pre-post intervention between-groups design to compare the impact of BodyfurnFlex and regular classroom chairs on students' academic achievement. This is a variation of a pretest-posttest control group design (or two-group random assignment pretest-posttest design), which is a powerful experimental method where participants are randomly divided into an intervention group (receives the intervention) and a control group (does not), with both groups measured before (pretest) and after (posttest) the introduction of the intervention, allowing researchers to confidently attribute any changes to the intervention by comparing how much each group changed from baseline (Tikkanen, 2017). The strength of this design, namely its ability to control for maturation or history (as these factors affect both groups similarly) and pre-existing group differences (by collecting baseline data), makes it well-suited for assessing student achievement (Shek & Zhu, 2018; Tikkanen, 2017). All other studies investigating the effect of dynamic seating on academic achievement (Fedewa et al., 2015; Joubert et al., 2017; Mead et al., 2016; Torbeyns et al., 2017) have employed a variation of this design.

Behaviour Recording/Sampling

Behavioural observations were conducted by reviewing the lesson video footage and recording each behaviour on the data collection sheets.

On-Task Behaviour was recorded using momentary time sampling at 20-second intervals, which involves recording whether the target behaviour occurred or did not occur at a specific moment (e.g., every 20 seconds) (Cooper et al., 2020, p. 111). Momentary time sampling is the most accurate method for measuring continuous activity behaviour, such as engagement, outside of continuous duration recording (i.e., measuring the exact length of time a behaviour occurs), which is time-consuming, difficult to implement accurately, and impractical with multiple participants (Cooper et al., 2020, p. 111). Using 20-second intervals for every participant allowed the behaviour to be measured with high reliability and validity, as intervals of less than 1 minute in momentary

time sampling have been shown to produce data similar to those from continuous-duration recording (Cooper et al., 2020, p. 111).

Disruptive behaviour was measured using event (or frequency) recording, which involves recording each occurrence of the behaviour (Cooper et al., 2020, p. 104). While event recording is not suitable for continuous, high-rate behaviours (such as engagement), it is useful for lower-frequency, discrete behaviours that have a clear beginning and end and can easily be missed by other sampling methods, such as momentary time sampling (Cooper et al., 2020, pp. 104, 108).

Out-of-Seat Behaviour and Chair Tipping were both measured using partial-interval recording at 20-second intervals, which involves recording whether the behaviour occurred at any point during the interval (Cooper et al., 2020, p. 110). Partial interval recording is beneficial for estimating the frequency and duration of a behaviour. It is beneficial for lower-frequency behaviours, particularly those that can vary significantly in duration (e.g., out-of-seat behaviour could last several seconds or minutes), for which other sampling methods, such as event or whole-interval recording (if the behaviour occurs for the entire interval), may under- or overestimate the occurrence of the behaviour (Cooper et al., 2020, pp. 110-111).

Interobserver Agreement

In Study 1, interobserver agreement (IOA) was used to assess the reliability of behavioural observations. IOA is the most common method for assessing the reliability of behavioural observations in ABA and refers to the degree to which two or more independent observers report the same observed values when measuring the same events (Cooper et al., 2020, p. 132). IOA serves several purposes, including: assessing the competence of the observer, detecting potential observer drift (when the observer unintentionally changes how they apply a measure to the behaviour over time, leading to inaccurate data collection), ensuring the behavioural operational definitions are clear and unambiguous, confirming that the recording/sampling method was accurate, and providing confidence that changes in the data accurately reflect actual changes in behaviour (Cooper et al., 2020, pp. 132-133).

Number of Sessions

According to Cooper et al. (2020), although IOA is recommended for at least 20% of sessions, it is generally preferable to obtain IOA for at least 25% of sessions (p. 138). Therefore, in the current study, IOA was collected for 25% of sessions in both groups. This included 7 of 25 sessions for Group A (28%) and 6 of 24 sessions for Group B (25%). Sessions were randomly selected, with at least one from each phase (i.e., A1, B1, A2, B2) for each group.

Selection of IOA Methods

Although many different methods exist for calculating IOA, there is no universally accepted best approach. However, Cooper et al. (2020) advise researchers to select the IOA method least likely to overestimate actual agreement, based on the sampling method and dataset, which may include calculating several methods to identify the most appropriate one (p. 139).

On-Task Behaviour was assessed using Interval-by-Interval IOA (also known as Total Agreement IOA), as it is generally recommended for behaviours recorded through momentary time sampling (Cooper et al., 2020, p. 139). This involves the primary observer's record for each interval being matched to the secondary observer's record for the same interval by dividing the total number of agreed intervals (i.e., where both observers marked the interval the same) by the sum of the number of intervals agreed and disagreed, then multiplying by 100 to give the IOA percentage (Cooper et al., 2020, p. 136).

Disruptive Behaviour observations were assessed using Scored Interval IOA, which is recommended for low-frequency behaviours (occurring in less than 30% of intervals) (Cooper et al., 2020, p. 137). This method involves examining only intervals where at least one observer recorded the behaviour, calculating agreement by dividing the number of intervals where both observers agreed by the total number of intervals where either observer recorded the behaviour, then multiplying by 100 (Cooper et al., 2020, p. 137). Although Exact Count Per Interval, Total Count Interval, and Mean Count Per Interval IOA are the most common methods for assessing data collected via event recording (Cooper et al., 2020, pp. 134-136), I found that these methods often

yielded percentages in the mid to high nineties, suggesting overestimated agreement, likely due to the relatively low occurrence of disruptive behaviours observed.

Out-of-Seat Behaviour and Chair Tipping observations were also assessed using Scored Interval IO, as both behaviours also occurred in less than 30% of intervals.

Secondary Observer

The second observer was a fellow postgraduate student from the University of Waikato, studying a Master's of Applied Psychology in Behaviour Analysis. I had no prior relationship with this student before their recruitment for IOA. Valid assessment of IOA requires the two observers to use the same measurement system (i.e., operational definitions and sampling/recording methods), observe/record the same participants and events, and conduct observations independently (Cooper et al., 2020, p. 133).

The observer was provided with a list of operational definitions (Appendix R), IOA sampling instructions (Appendix S), and the data coding sheets (Appendices N-Q) for each behaviour. Additionally, I met with the secondary observer to explain the instructions and definitions, demonstrate how to conduct the observations and complete the data collection sheets, and answer any questions. I supplied individualised data coding sheets for each session, including the video's start time (i.e., the time to begin observations). Following this, the secondary observer completed a practice session, for which I provided feedback and addressed any questions. After the practice, the secondary observer conducted observations independently. It should be noted that the secondary observer was not blind to the condition (i.e., baseline versus intervention), as it was obvious which chairs were in use.

Data Analysis

Studies 1 and 2

Visual Analysis. One of the primary methods of analysing data in ABA is visual analysis. It involves inspecting graphically displayed data to answer two main questions: Did the behaviour change in a meaningful way? and to what extent can that behavioural change be attributed to the

independent variables (i.e., is there a functional relationship) (Cooper et al., 2020, p. 168). Although there are no official, formalised rules for conducting visual analysis, it typically entails examining the variability, level, and trend of behavioural data across and within the conditions and phases of an experiment (Cooper et al., 2020, pp. 168-169). Firstly, behavioural data are examined within phases to determine the degree of variability, levels of the behaviour, and the direction and degree of any trends (Cooper et al., 2020, pp. 170-172). Next, data are examined across phases, starting with the difference between the last data point before the condition change and the first data point of the new condition (i.e., was there an immediate and noticeable change coinciding with the introduction or removal of the intervention). Additionally, the difference in overall level between phases needs to be examined (i.e., to what degree is there overlap between conditions) (Cooper et al., 2020, pp. 173-174).

Effect Size. Tau-U (Parker et al., 2011) was used to calculate effect sizes and complement visual analysis by quantifying the magnitude of the treatment effect. Tau-U was selected over other non-overlap effect size calculations commonly used in SCR, including NAP (Nonoverlap of all Pairs), PND (Percentage of Non-overlapping Data), PAND (Percentage of All Non-overlapping Data), and PEM (Percentage Exceeding the Median) for several reasons. Firstly, unlike the other effect size measures mentioned, Tau-U can account for baseline trends (Parker et al., 2011). This is important to prevent drawing incorrect conclusions about an intervention's effectiveness, as a pre-existing trend in the baseline phase might make it appear that the intervention caused a change when, in reality, the behaviour was already changing naturally. Conversely, if the intervention reverses the trend, you can have a large and meaningful change while still having 100% overlap and miss the intervention effect entirely.

Secondly, Tau-U is far less susceptible to ceiling effects than other nonoverlap effect sizes (Parker et al., 2011). Ceiling effects pose a significant challenge for nonoverlap effect sizes used in SCR, as they prevent distinguishing between different levels of highly effective interventions once complete nonoverlap is achieved. This means that multiple interventions with genuinely different

levels of impact might all receive the maximum effect size (i.e, 100% or 1.0), concealing the actual differences in effectiveness.

Finally, Tau-U provides p-values for its effect size, indicating whether there is a statistically significant difference between conditions (i.e., that the observed improvement (nonoverlap) is likely due to the intervention and not just chance) (Brossart et al., 2018; Lee & Cherney, 2018; Parker et al., 2011). This can be a valuable addition to visual analysis results, especially when data patterns are unclear.

It should be noted that the use of effect sizes in SCR is still a relatively new and evolving field. While many effect size calculations are used in SCR, including several Tau variants, there is currently no consensus among researchers on the most appropriate method (Tincani et al., 2025).

Tau-U effect sizes were calculated using the online calculator developed by Vannest et al. (2016) and following the provided instructions, both of which are available at singlecaseresearch.org. This is the most up-to-date version of the original Tau-U calculator created by the Tau-U developers (Parker et al., 2011), and is commonly used by researchers to calculate Tau-U effect sizes in SCR (Phillips et al., 2022; Sleiman et al., 2020). Calculations involved entering each observed data point for each phase (A1, B1, A2, and B2) into separate input fields. Each baseline phase (A1 and A2) was then checked to assess if there was a significant baseline trend. Tau-u effect sizes were then calculated for each baseline phase and the subsequent intervention phase (i.e., A1 v B1 and A2 v B2), with the 'correct baseline trend' option selected for baseline phases with a significant baseline trend. Finally, both effect sizes (A1 v B1 and A2 v B2) were combined using the 'weighted average' function, providing a single Tau-U effect size for that behaviour.

Correlations. Spearman's rank correlation coefficient was used to calculate correlations between the dependent variables in Study 2. Spearman's correlation coefficient (nonparametric) was chosen over the more commonly used Pearson's correlation coefficient (parametric) because the data did not meet all the assumptions required for parametric testing. The Shapiro-Wilk Test was used to assess the normality of each variable's distribution, a key assumption for parametric testing

(Field, 2009, pp. 132-148). The results showed that out-of-seat behaviour was not normally distributed, meaning that it was not suitable to use Pearson's coefficient for calculating correlations. Additionally, some behavioural data contained notable outliers (in particular, chair tipping), in which case Spearman's rank correlation is generally recommended over Pearson's correlation as it uses data ranks instead of actual values, making it less susceptible to outliers (de Winter et al., 2016; Kim et al., 2015; Schober et al., 2018).

Study 3

Comparison of Test Grades Between and Within Groups. The Mann-Whitney U test was used to compare grades between the control and intervention groups, while the Wilcoxon Signed-Rank test was used to compare baseline and post-intervention grades within each group. The non-parametric tests were selected to analyse the test data over their parametric equivalents, the Independent Samples t-test and the Paired Samples t-test, because the test data were ordinal, meaning they did not meet the assumptions of parametric testing (Field, 2009, p. 540).

Thematic Analysis of Focus Group Discussions. Braun and Clarke's (2006) approach was used to analyse the focus group discussion due to its widespread use, flexibility, rigour, and reflexive approach (Ahmed et al., 2025; Byrne, 2022; Campbell et al., 2021). As outlined by Braun and Clarke (2006), six steps were followed to analyse the focus group discussions: familiarisation with the data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and reporting the results.

Familiarisation with the Data. The first step involved transcribing each discussion and rereading the transcripts multiple times to become thoroughly familiar with the data.

Generating Initial Codes. The next step involved systematically coding interesting features across the entire data set and combining data relevant to each code (short descriptive tags).

Searching for Themes. Codes were then grouped into broader themes that reflect meaningful data patterns (i.e., grouping codes into overarching patterns that tell a bigger story about the data).

Reviewing Themes. Themes were then refined by checking whether they accurately represented the coded data and formed a coherent set (i.e., ensuring coherence within themes and clear distinctions between them). This includes potentially merging, splitting, or discarding themes.

Defining and Naming Themes. Themes were further refined by generating clear definitions and names for each theme, describing how each relates to the research aims, and selecting supporting quotes.

Reporting Results. Finally, the findings were presented in a coherent narrative that links them back to the research aims, other results (e.g., test grades), and the current literature in the final discussion section.

Chapter 4: Study 1

The Effect of BodyfurnFlex Chairs on the Movement and Behaviour of Students

Study 1: The Effect of BodyfurnFlex Chairs on the Movement and Behaviour of Students is a manuscript submitted for publication in Learning Environments Research and formatted according to the journal's requirements.

The Effect of BodyfurnFlex Chairs on the Movement and Behaviour of Students

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Statements and Declarations

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Competing Interests

The authors declare that they have no competing interests.

Ethics Approval

The study received ethical approval from the University of Waikato Human Ethics Research Committee (Ref: FS2022-61).

Consent

Informed consent was obtained from participating students and their parents/guardians.

Note

Callaghan Innovation (https://www.callaghaninnovation.govt.nz/).

Resero (https://www.reserogroup.com/). Resero is the parent company of Furnware (https://www.furnware.com/en-nz) who are the developers of BodyfurnFlex chairs.

Abstract

The physical environment can significantly influence students' learning and behaviour. One particularly important aspect of the physical learning environment is the classroom chairs. Traditional classroom chairs are often rigid and inflexible, leading to uncomfortable, static sitting. Conversely, dynamic chairs are designed to be flexible and encourage natural movement, which is believed to enhance student comfort and behaviour. This study examined whether a new type of dynamic chair, the BodyfurnFlex chair, could increase student movement and improve classroom behaviour. A multiple baseline with ABAB reversal design was used to compare the effects of the BodyfurnFlex chairs on the on-task, disruptive, out-of-seat, and chair tipping behaviours of students to traditional classroom chairs. We also examined whether the BodyfurnFlex chairs affected students' movement, including in-chair and overall classroom movement, as well as their perceptions of the chairs. The environmental conditions in the classroom were also monitored as potential confounding variables. The findings revealed that when students used the BodyfurnFlex chairs, there was a significant increase in time spent on-task, a decrease in disruptive behaviour, and a significant reduction in chair tipping and out-of-seat behaviour. Furthermore, both in-chair movement and overall movement in the classroom increased when students sat in the BodyfurnFlex chairs. Most participants reported preferring the BodyfurnFlex chairs, finding them more comfortable due to their flexibility, which they felt made it easier to complete their schoolwork. These findings suggest that BodyfurnFlex chairs can be an effective intervention for reducing uncomfortable static sitting and improving classroom behaviour.

Keywords: student engagement, dynamic chairs, active sitting, physical learning environment, classroom behaviour, flexible furniture

Introduction

A recent report from the Education Review Office (ERO) revealed that poor behaviour, including disruptive behaviour and lack of engagement, is a prevalent issue in New Zealand classrooms and is getting worse (Education Review Office, 2024). The report found that over the last 20 years, New Zealand classrooms have consistently had worse behaviour compared to most other OECD nations. In addition to negatively affecting teachers' well-being (Kollerová et al., 2023; van den Brink et al., 2025), poor behaviour can have a significant negative impact on students' academic achievement (Blank & Shavit, 2016; Wong et al., 2024). To address the issue of poor student behaviour, the ERO emphasised the importance of schools adopting evidence-based strategies/interventions that promote positive behaviour (Education Review Office, 2024).

One approach that schools have adopted to improve student behaviour is by integrating movement into the classroom. Most commonly, this has been implemented using movement breaks (a short break in the lesson that involves physical activity) (Gilmore et al., 2024; Turner & Chaloupka, 2017). While movement breaks have been shown to significantly increase students' engagement and reduce disruptive behaviours **(**Broad et al., 2023; Mavilidi et al., 2020; Moon et al., 2022**),** they interrupt the lesson (reducing valuable learning time) and require teachers to be trained on how and when to implement them (Goh et al., 2018; Kerpan et al., 2019).

A potential alternative to movement breaks for integrating movement into the classroom, without a break in the lesson or teacher training, is dynamic chairs. Unlike standard classroom chairs, which are typically inflexible and restrict movement, dynamic chairs are made to be flexible and promote movement, which is hypothesised to improve student engagement and reduce disruptive behaviours (Rollo et al., 2019). However, currently, there is a lack of research investigating the effect of dynamic chairs on student behaviour or movement in the classroom. The aims of this study were to: (1) examine whether dynamic chairs can increase students' movement in the classroom and (2) investigate whether dynamic chairs can improve students' behaviour.

Literature Review

Student engagement can be broadly defined as students being actively involved in their learning tasks and activities (Lei et al., 2018). Student engagement is multidimensional and includes three key aspects: cognitive engagement, emotional engagement, and behavioural engagement (Lei et al., 2018; Wong et al., 2024). Behavioural engagement, also known as on-task behaviour (Caldarella et al., 2021; Philp & Duchesne, 2016), refers to the observable actions of student engagement (Cappella et al., 2013; Reeve et al., 2020). While all three aspects of student engagement have a significant positive correlation with academic achievement, behavioural engagement has a notably larger correlation with academic achievement than the other aspects (including all three components of student engagement combined) (Lei et al., 2018; Wong et al., 2024). Conversely, disruptive behaviour has been shown to have a significant negative effect on the academic achievement of not only the students who exhibit disruptive behaviours (Finn et al., 1995; Flores-Mendoza et al., 2013) but also the entire classroom (Bäckström, 2021; Blank & Shavit, 2016). Two of the most common and problematic classroom disruptive behaviours are chair tipping (Cogswell et al., 2020; Zuniga & Cividini-Motta, 2022) and out-of-seat behaviour (Axup & Gersch, 2008; Infantino & Little, 2005).

The physical learning environment can have a significant impact on students' learning and behaviour, including the classroom design/layout (Imms & Byers, 2017), lighting (Pulay & Williamson, 2019), furniture (Morris & Imms, 2024), and the environmental conditions such as carbon dioxide (CO_2) concentration, temperature, and humidity (Bhandari et al., 2024; Brink et al., 2021; Gao et al., 2020). One particularly important aspect of the physical learning environment is the classroom chairs, with students spending up to 97% of class time seated in traditional schools (Cardon et al., 2004). Regular/standard classroom chairs are designed to be durable, cost-effective, and efficient (i.e., easy to store/stack and move). These chairs are often rigid and inflexible, resulting in static sitting (i.e., sitting in the same posture/position without moving). Prolonged static sitting is associated with pain and discomfort (Caromano et al., 2015; Waongenngarm et al., 2015; Zemp et

al., 2016), which has been shown to negatively impact students' attention and engagement (Aga, 2024; Groenewald et al., 2020; Moore et al., 2019). Pain/discomfort also appears to be a key reason for students engaging in disruptive behaviours such as out-of-seat behaviour and chair tipping (Knight & Noyes, 1999; Udo et al., 1999). Udo et al. (1999) found that chair tipping resulted in reduced back pain, while another study found that 67% of students stated that they would rock/tip on their chairs as a response to feeling uncomfortable (Knight & Noves, 1999). Knight and Noyes (1999) also found that 48% of the participants reported that they would engage in out-of-seat behaviour at some point due to discomfort.

Recently, many schools have looked to incorporate alternative dynamic/flexible seating options in their classrooms to improve student comfort and behaviour (Attai et al., 2021; Putman et al., 2024). In contrast to traditional classroom chairs, dynamic seating is designed to promote movement through active sitting. Active or dynamic sitting refers to consistent movement through postural changes (Akkarakittichoke et al., 2023; Arippa et al., 2022). One type of dynamic seating that has been studied extensively is stability balls, which have been shown to improve on-task behaviour and decrease disruptive behaviours of students with Attention Deficit Hyperactivity Disorder (ADHD) and Autism Spectrum Disorder (ASD) (Fedewa & Erwin, 2011; Matin Sadr et al., 2017; Schilling & Schwartz, 2004). However, when implemented in mainstream classrooms, stability balls have actually been shown to have a negative effect on students' behaviour in comparison to regular classroom chairs (Fedewa et al., 2015; Hulac et al., 2020). Furthermore, research has shown that in comparison to regular (non-dynamic) chairs, stability balls actually decreased the movement of students (Erwin et al., 2016), suggesting that they are not effective at reducing static sitting.

Currently, there is a lack of research on how other types of dynamic seating, aside from stability balls, affect the behaviour of mainstream students (Rollo et al., 2019). Rollo et al. (2019) conducted a systematic review on the effects of dynamic seating on students' learning. They found that although dynamic seating can positively influence the behaviour of students with ASD and ADHD, there is no evidence that it can improve the behaviour of general education students.

Additionally, it was highlighted that more rigorous and detailed research is needed into the effects of dynamic seating beyond stability balls (Rollo et al., 2019).

One type of dynamic seating that may have a positive effect on student behaviour is dynamic chairs. Although dynamic chairs are a type of dynamic seating, they are not directly comparable to other dynamic seating options, such as stability balls. A dynamic chair is a typical chair that includes dynamic features (i.e., features that enable movement) such as flexible backrest and seat panels (Hyeong et al., 2014). Unlike stability balls, dynamic chairs have been shown to significantly increase the movement of occupants in comparison to static (non-dynamic) chairs (Grooten et al., 2017; Nüesch et al., 2018; Tanoue et al., 2016), suggesting that they can effectively reduce static sitting. However, it is important to note that this has not yet been shown with students in a classroom environment, as the aforementioned studies involved adult participants in office/laboratory settings (Grooten et al., 2017; Nüesch et al., 2018; Tanoue et al., 2016). Dynamic chairs have also been shown to improve the comfort of users in comparison to non-dynamic chairs (Frey et al., 2021; Garcia et al., 2016), suggesting that they may be able to increase students' on-task behaviour and decrease disruptive behaviours such as chair tipping and out-of-seat behaviour.

These findings suggest that by increasing in-chair movement and decreasing discomfort, dynamic chairs may be able to have a positive effect on students' behaviour. However, currently, there is a lack of research directly comparing the effect of dynamic and regular chairs on student behaviour in the classroom. Considering that many schools are investing in more expensive dynamic chairs, there is an urgent need to investigate whether these chairs are an effective intervention for improving student behaviour and whether they are a worthwhile investment for schools. Imms et al. (2020) suggested the use of longitudinal, withdrawal, single-case experimental designs to analyse the effect of furniture on student engagement.

The current study attempts to address this gap in the literature by investigating the effect of a new type of dynamic school chair, the BodyfurnFlex chair (Furnware, n.d.), on the on-task, disruptive, out-of-seat, and chair tipping behaviour of students in comparison to regular classroom

chairs. The study also investigated whether BodyfurnFlex chairs affected the movement of students, measuring both in-chair and overall movement levels in the classroom. Environmental data, including classroom temperature, humidity, and CO_2 levels, were also measured as potential confounding variables. Additionally, social validity data was collected in the form of a participant survey to measure students' preferences/opinions on the chairs and whether they felt they made it easier to complete their work. Social validity data is crucial to ensuring that an intervention is acceptable, important, meaningful, and worthwhile for those experiencing it (Huntington et al., 2023).

Methods

Participants

Data was collected from two separate classrooms involving a total of 60 students. The first classroom (Class A) was an intermediate school maths class with 31 students aged between 11 and 13 years. The second classroom (Class B) was a secondary school English class with 29 students aged 13 to 14 years. Overall movement and social validity data were collected for the entire classroom, while in-chair movement and behavioural data were collected for 10 students in each classroom (Groups A and B). The 10 students were selected using purposive sampling, with the selection criteria being good attendance and average/middling performance in the target behaviours relative to the class population. Good attendance was included to avoid participant absences, while participants with middling/average performance in the target behaviours were selected to be a representative sample of the classroom and to minimise the likelihood of ceiling/floor effects. The teachers in the classrooms selected the 10 students who best met the selection criteria based on their own experience and knowledge of the students. Both groups included five female and five male participants.

Materials

Chairs

Two types of chairs were used in the study: the regular classroom chairs and BodyfurnFlex chairs. The size of the chairs used for each classroom was determined by the age group of the students.

The **BodyfurnFlex chair** (Figure 1) is a dynamic chair with an independently moving polypropylene seat and backrest connected to a high-tensile steel frame with a sled base (Furnware, n.d.). The BodyfurnFlex chairs for Class A had a seat height of 410mm and an overall height of 777mm, while Class B's chairs had a seat height of 460mm and an overall height of 872mm.

Figure 1

BodyfurnFlex Chair

The **regular classroom chairs** were monobloc (single-piece), non-dynamic, polypropylene chairs. Both groups used chairs with similar designs but different brands. The regular chairs used for Class A (Figure 2) had a seat height of 430mm and an overall chair height of 799mm, while Class B's regular chairs (Figure 3) had a seat height of 460mm and an overall chair height of 805mm.

Figure 2

Class A Regular Classroom Chair

Figure 3

Class B Regular Classroom Chair

Smart Classroom System

The Smart Classroom System is a network of sensors created by the project stakeholders to monitor movements and environmental conditions within the classroom. The system includes two different types of sensors: Nordic Thingy:52 sensors (Nordic Semiconductor, n.d.) and Raspberry Pi cameras (Raspberry Pi, n.d.-b), which wirelessly connect to an app that is used to remotely control the sensors.

The Thingy:52 is a compact, multi-sensor device that includes several environmental sensors for CO_2, temperature, and humidity. Additionally, it includes several motion sensors: an accelerometer for velocity changes, a gyroscope for changes in orientation, and a magnetometer for direction. Each sensor detects motion along three axes: x, y, and z, enabling nine-axis motion sensing for detailed movement measurement (Nordic Semiconductor, n.d.).

Raspberry Pis are small single-board computers that are designed to be low-cost and versatile. The Raspberry Pis in the Smart Classroom System were adapted to act as motion sensors using the Raspberry Pi camera module (Raspberry Pi, n.d.-a). The Raspberry Pi cameras capture black-and-white video footage, which is then used to detect motion through a method called frame differencing. Frame differencing is a computer vision technique that identifies motion in video footage by comparing pixel changes between frames. Larger pixel changes from one frame to the next indicate greater motion in the video.

The Smart Classroom App was developed by engineers at Callaghan Innovation using Python programming software (Python, n.d.). The app allowed users to start and stop sensor recordings, with data transmitted directly from the sensors to the app. Users could download data from each session in Excel spreadsheets that included a full list of measurements for each variable. Each measurement was timestamped, enabling users to select relevant data and exclude unrelated data (e.g., from specific time frames). The Thingy:52 sensors recorded data every 1,000 milliseconds (ms), while the Raspberry Pi cameras recorded every 500 ms. All data was presented as the group mean

(i.e., the average value across all sensors) for both the Thingy:52 and Raspberry Pi sensors. Before data collection, all sensors were calibrated by the engineers to ensure accurate measurements.

Video Camera

An HDR-CX405 Handycam® (Sony, n.d.) mounted on an Inca I3530D Tripod (Manfrotto, n.d.) was used to record class sessions.

Participant Survey

The researchers developed a survey to collect social validity data from participants. The survey asked students to indicate which chair they preferred sitting in and whether they felt that either chair made it easier to complete their schoolwork, as well as to provide reasons for their answers. Additionally, students were asked if they had any further feedback about the chairs or study (Appendix).

Procedure

Design

This study is presented as a single-case research design, with each group representing a single case. This study implemented a multiple baseline across groups with an integrated ABAB reversal design, alternating between baseline (Regular chairs - A) and intervention (BodyfurnFlex chairs - B) conditions. Phase changes were implemented only after several sessions of stable on-task behaviour had been established.

Dependent Variables

This study included six dependent variables: on-task behaviour, disruptive behaviour, out-of-seat behaviour, chair tipping, in-chair movement, and overall movement in the classroom.

On-task behaviour was defined as being actively engaged in learning activities. For a student to be marked as on-task, they had to attend to or be engaged in the assigned task either visually (e.g., looking at the teacher, speaker, or task material), verbally (e.g., asking/answering questions or discussing the task), or physically (e.g., writing, glueing, or cutting). Additionally, following the

teacher's instructions (e.g., "when you finish your work, sit and wait quietly" or "can you go and close that window, please") was also considered on-task behaviour.

Disruptive behaviour was functionally defined as any behaviour that caused another student to stop their on-task behaviour (i.e., become off-task) or caused the teacher to stop teaching. Task-related behaviours such as asking questions or engaging in task-related discussion were not deemed as disruptive behaviours.

Out-of-seat behaviour was defined as any time a student's backside lost contact with the seat of the chair without permission from the teacher (e.g., permission to go to the bathroom) or when it was not directly related to the task (e.g., standing up to fetch a pair of scissors).

Chair tipping was defined as any instance where a student was seated and any part of a chair leg or base lost contact with the floor.

In-chair movement was calculated using the nine-axis motion data and converted into a movement index that represents the size/magnitude of movement (i.e., displacement). This movement index is a ratio variable (i.e., an index of 0 indicates no movement, and an index of 2 indicates twice the movement of an index of 1).

Overall movement in the classroom was converted into a turbidity index, which represents the proportion of pixel changes from one video frame to the next, with a value of 0 indicating no pixel changes and a value of 1 indicating every single pixel changed.

Additionally, the Thingy:52 sensors measured several environmental factors, including CO_2 concentration, temperature, and humidity. The Ministry of Education requires the daily average CO_2 concentration to stay below 1,250 ppm, while the classroom temperature and humidity must remain between 18-25 °C and 35-70%, respectively (Ministry of Education, 2022).

Participant Recruitment

All students and their parents/guardians were provided with participant information sheets and assent/consent forms. Signed assent/consent was collected from the 10 selected students and

their parents/guardians, while passive assent/consent was obtained from all other students and their parents/guardians prior to data collection.

Setting

Classrooms were arranged in a traditional layout, with the teacher at the front and students seated around tables. Two Thingy:52 sensors were attached to the 10 chairs of the selected participants (Groups A and B) in each classroom using Velcro patches (Velcro, n.d.). One sensor was placed under the seat, and the other on the backrest, in the same position on each chair. The chairs were arranged around two adjacent tables (five chairs per table). The video camera was placed at the side of the room against a wall and focused solely on the tables of the 10 selected students. These tables were positioned on the far side of the room for both classes, allowing other students to avoid being on camera. The two motion sensor cameras were positioned in opposite corners of the classroom to eliminate blind spots. The classroom layout and chair positions remained unchanged throughout data collection.

Data Collection

Data was collected during regular class periods, with all equipment set up before class began and removed afterwards. There were two data collection sessions per week for each classroom, with data collection for Class B beginning two weeks after Class A. Any sessions that involved pedagogical outliers (e.g., sessions that deviated from typical classroom lessons, such as test-taking classes or those with a substitute teacher) were excluded from the results. There was a total of 25 sessions for Class A and 24 for Class B.

Behaviour Observations

One of the researchers conducted behaviour observations by reviewing video footage of the lesson and recording each behaviour on data collection sheets. Observations commenced once all participants were seated and the teacher officially began the lesson. The observation period lasted for the next 25 minutes from the start of the lesson, during which behavioural data was recorded.

On-task behaviour was recorded using momentary time sampling at 20-second intervals, with each participant being marked as either on-task or not on-task at the 20-second mark of each interval. If a student was not present at the 20-second mark of an interval (e.g., they went to the bathroom) and provided they had permission to leave or there was evidence that they left for a task-related reason (e.g., they returned with a pair of scissors), they were marked as absent for that interval. However, if a student did not have permission to leave or did not show evidence that they left for a task-related reason, they were marked as not on-task. On-task behaviour was converted to a percentage for each student (i.e., the percentage of intervals where students displayed on-task behaviour), with absent intervals excluded.

Disruptive behaviour was measured using event recording, with each instance/occurrence of disruptive behaviour being tallied. Students were marked as absent only if they were off camera for the entire interval. The scores were converted to the mean number of disruptive behaviour occurrences per hour for each student.

Out-of-seat behaviour and chair tipping were measured using partial interval recording at 20-second intervals. If a participant exhibited out-of-seat behaviour or chair tipping at any point during the 20-second interval, the behaviour was marked as present. Both behaviours were converted to a percentage (i.e., the percentage of intervals the behaviour was displayed) for each student.

Movement and environmental data collected during the 25-minute observation period were downloaded for data analysis. Due to technical and connection issues, several sessions had incomplete and/or corrupted data and were excluded from the results, with four sessions removed for both groups/classes.

Students completed the participant survey following the conclusion of the final data collection session.

Data Analysis

Each dependent variable was graphed over the course of data collection, with each data point representing the group mean for a session. Visual analysis involved comparing differences in

the trend, level, and variability of data between baseline and intervention phases. In addition to visual analysis, Tau-U was used to calculate the size and significance of the effect.

The reliability of the behavioural data coding was assessed through interobserver agreement (IOA) for 25% of the sessions. On-task behaviour was measured using total agreement IOA, while disruptive, out-of-seat, chair tipping behaviours were assessed using scored interval IOA. On-task behaviour showed a mean total agreement IOA of 95.8% for Group A and 94.3% for Group B. The scored interval IOA for Groups A and B averaged 85.7% and 88.4% for disruptive behaviour, 94.4% and 90.3% for out-of-seat behaviour, and 91.0% and 93.1% for chair tipping.

Results

On-Task Behaviour

Mean on-task percentages for Groups A and B are displayed in Figure 4 and summarised in Table 1.

Figure 4 shows that Group A baseline levels of on-task behaviour (A1) remained relatively stable (*M* = 76.3%), except for session 3. The introduction of the intervention (B1) coincided with a noticeable increase in on-task behaviour, which remained stable throughout the phase and consistently above baseline levels (*M* = 85.5%). A return to baseline conditions (A2) resulted in a visible decrease in on-task behaviour and a return to baseline levels (*M* = 75.8%). The reintroduction of the intervention (A2) was associated with an immediate increase in on-task behaviour that remained stable throughout the phase (*M* = 82.2%).

The Group B baseline levels of on-task behaviour remained relatively stable (*M* = 72.1%). The introduction of the intervention resulted in an immediate increase in on-task behaviour that consistently remained above baseline levels (*M* = 80.1%). The second baseline phase coincided with a noticeable decrease in on-task behaviour, which remained relatively stable with a slight decreasing trend (*M* = 67.9%). The reintroduction of the intervention again resulted in an immediate increase in on-task behaviour, which remained relatively stable (*M* = 76.2%), with all but one session remaining above A2 levels.

In every case, changes in the independent variable (chair type) were associated with immediate changes in the dependent variable (on-task behaviour), demonstrating a clear functional relationship.

Table 1 shows that on-task behaviour increased during the intervention condition for both groups, with large, significant effect sizes for both Group A (.95, $p < .01$) and Group B (.92, $p < .01$), indicating that the intervention had a large positive effect on the on-task behaviour of students.

Figure 4

Mean Percentage of On-Task Behaviour across Sessions for Groups A and B

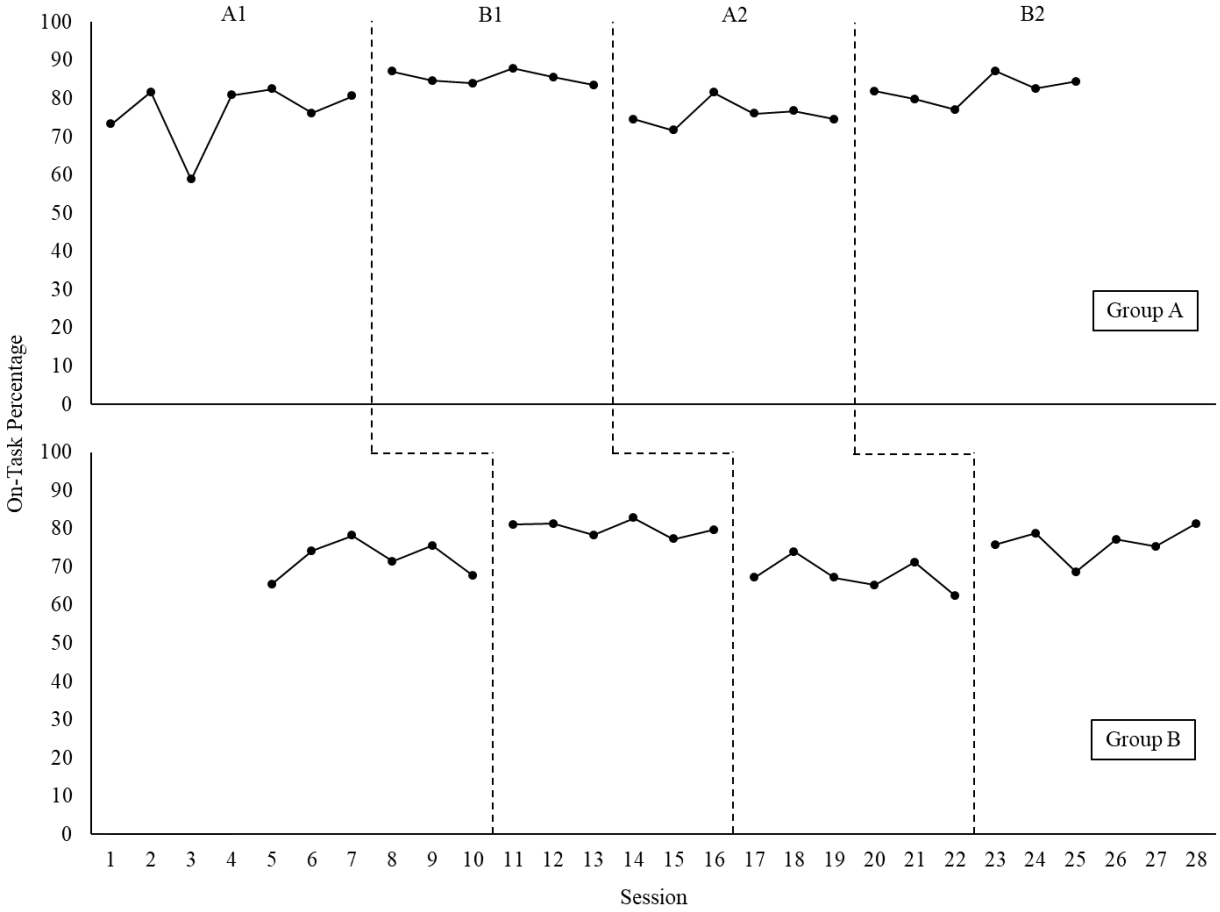

Table 1

Mean Percentage of On-Task Behaviour across Conditions and Effect Sizes for Groups A and B

	Group A			Group B		
	Baseline (*n* = 13)	Intervention (*n* = 12)	Tau-U	Baseline (*n* = 12)	Intervention (*n* = 12)	Tau-U
On-Task Percentage	76.1%	83.9%	.95**	70.0%	78.1%	.92**

Note: *$p < .05$, **$p < .01$

Disruptive Behaviour

The mean number of disruptive behaviour occurrences per hour is presented in Figure 5 and Table 2.

Figure 5 shows that Group A baseline levels of disruptive behaviour displayed a high level of variability (*M* = 10.1). Levels of disruption stabilised during the first intervention phase, which displayed a slight increasing trend and a decrease in mean from the baseline (*M* = 8.7). The return to baseline conditions was associated with an initial decrease in disruptive behaviour and increased variability, with a mean of 9.7 disruptive behaviour occurrences per hour. The reintroduction of the intervention resulted in an immediate decrease in disruptive behaviour (*M* = 7.3).

The Group B baseline levels of disruptive behaviour were also highly variable (*M* = 14.5). The introduction of the intervention did not reduce the variability but was associated with a sizeable reduction in disruptive behaviour (*M* = 10.2). Levels of disruption were more stable in the second baseline phase and returned to the initial baseline mean (*M* = 14.8). The reintroduction of the intervention resulted in an immediate decrease in disruptive behaviour, with all but one session remaining below phase A2 levels (*M* = 9.8).

Table 2 shows that the mean frequency of disruptive behaviours decreased during the intervention condition for both groups. However, the intervention only resulted in a small non-significant decrease in disruptive behaviour in Group A (-.35, $p = .15$) but a significant moderate decrease in Group B (-.75, $p < .01$).

Figure 5

Mean Disruptive Behaviour Occurrences per Hour across Sessions for Groups A and B

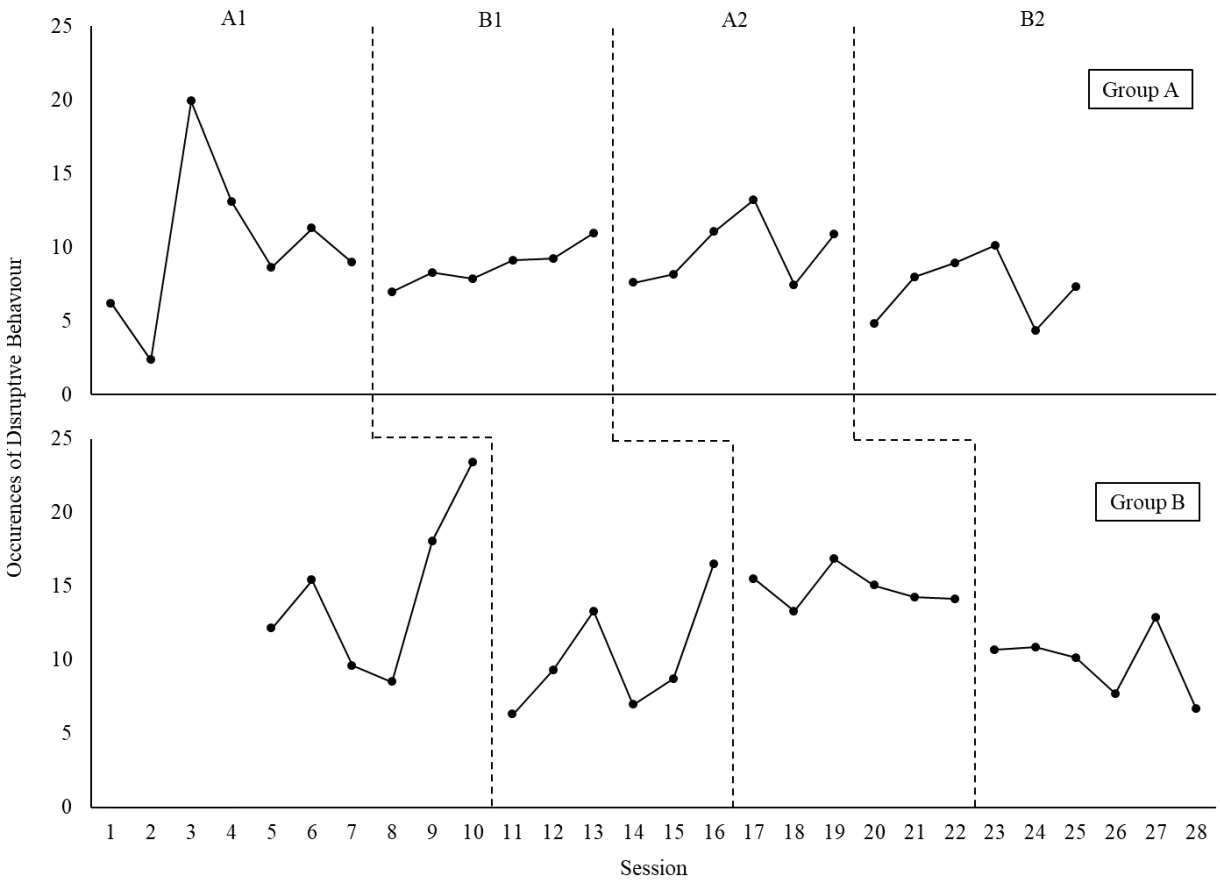

Table 2

Mean Disruptive Behaviour Occurrences per Hour across Conditions and Effect Sizes for Groups A and B

	Group A			Group B		
	Baseline (*n* = 13)	Intervention (*n* = 12)	Tau-U	Baseline (*n* = 13)	Intervention (*n* = 12)	Tau-U
Disruptive Behaviours	9.9	8.0	-.35	14.7	10.0	-.75**

Out-of-Seat Behaviour

The mean percentage of intervals where students displayed out-of-seat behaviour is displayed in Figure 6 and Table 3.

Figure 6 shows that the Group A baseline levels of out-of-seat behaviour showed an increasing trend, except for session 6 (*M* = 3.24%). The first intervention phase showed moderate

variability in out-of-seat behaviour and a noticeable decrease in level from baseline (*M* = 1.40%). The return to baseline conditions was associated with an immediate increase in the level and variability of out-of-seat behaviour (*M* = 2.93%). The second intervention phase, with the exception of session 20, remained stable and well below baseline levels (*M* = 1.11%).

The Group B baseline levels of out-of-seat behaviour were reasonably stable with a slight increasing trend (*M* = 1.27%). The introduction of the intervention was associated with increased variability in out-of-seat behaviour but no clear change in mean from the baseline (*M* = 1.33%). The second baseline phase resulted in an immediate increase in out-of-seat behaviour and high variability across sessions (*M* = 1.82%). The reintroduction of the intervention was associated with moderate variability and a decrease in mean out-of-seat behaviour from A2 (*M* = 1.05%).

Table 3 shows that out-of-seat behaviour decreased during the intervention condition for both groups. The intervention resulted in a large, significant decrease in out-of-seat behaviour in Group A (-.87, $p < .01$) and a small, non-significant decrease in Group B (-.35, $p = .16$).

Figure 6

Mean Percentage of Intervals during which Students Displayed Out-of-Seat Behaviour across Sessions for Groups A and B

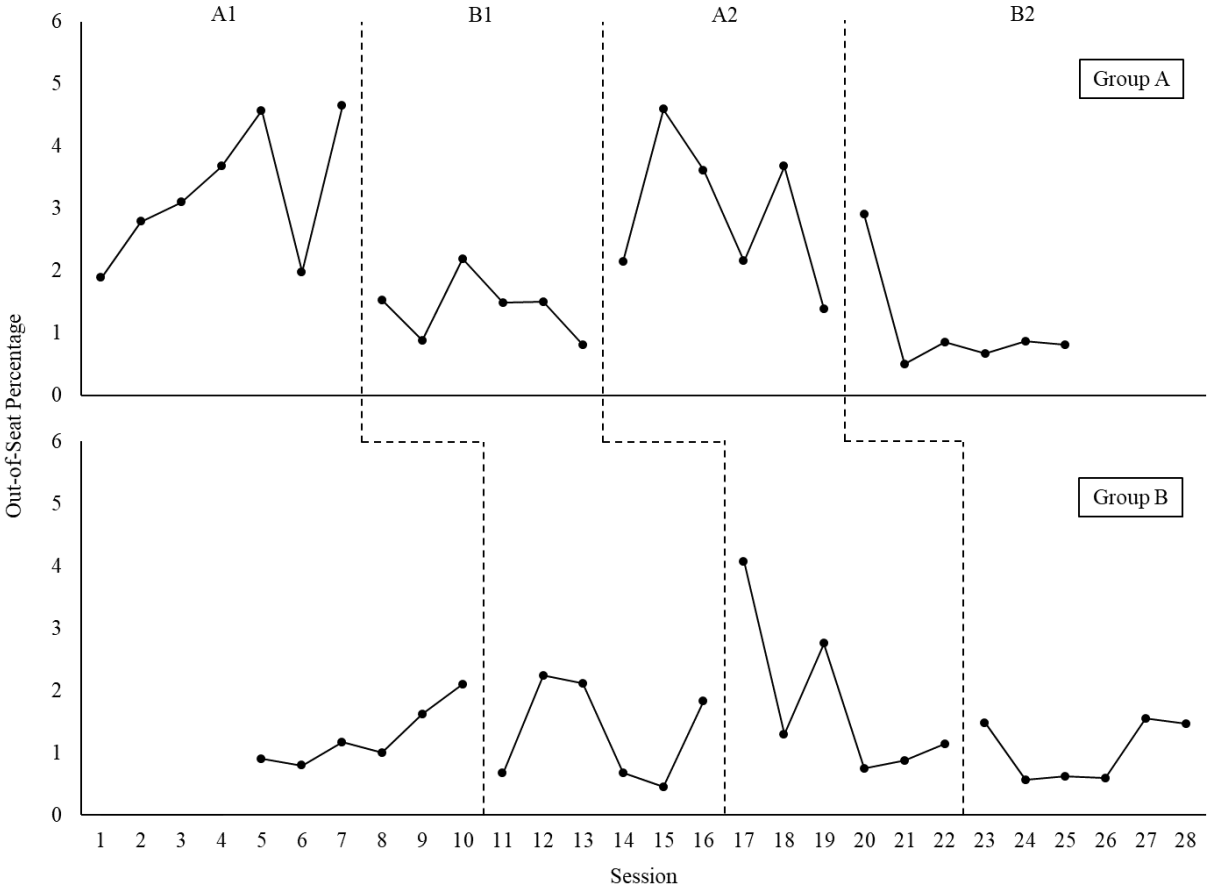

Table 3

Mean Percentage of Intervals during which Students Displayed Out-of-Seat Behaviour across Conditions and Effect Sizes for Groups A and B

	Group A			Group B		
	Baseline (*n* = 13)	Intervention (*n* = 12)	Tau-U	Baseline (*n* = 13)	Intervention (*n* = 12)	Tau-U
Out-of-Seat Percentage	3.10%	1.26%	-.87**	1.54%	1.19%	-.35

Chair Tipping

The mean percentage of intervals during which chair tipping occurred for Groups A and B is presented in Figure 7 and Table 4.

Figure 7 shows that Group A baseline levels of chair tipping were highly variable (*M* = 2.53%). During the first intervention phase, the behaviour stabilised with low levels of chair tipping and a decrease in mean from the baseline (*M* = 0.26%). The reinstatement of the baseline conditions was associated with an increase in variability and mean chair tipping levels (*M* = 1.17%). The second intervention phase was associated with moderate variability but a decrease in mean levels in chair tipping from A2 (*M* = 0.35%).

The Group B baseline levels of chair tipping, except for session 10, showed a slight increasing trend (M = 0.56%). The first intervention phase was associated with stable and low levels of chair tipping and a noticeable decrease in mean from the baseline (*M* = 0.15%). On returning to baseline conditions, the variability and mean chair tipping levels increased (*M* = 1.02%). The reintroduction of the intervention resulted in an immediate drop in chair tipping, which remained stable and at very low levels throughout the phase (*M* = 0.06%).

Table 4 shows that chair tipping decreased during the intervention condition for both groups. The intervention resulted in a moderate, significant decrease in chair tipping for Group A (-.76, $p <$ .01) and Group B (-.79, $p <$ .01).

Figure 7

Mean Percentage of Intervals during which Students displayed Chair Tipping across Sessions for Groups A and B

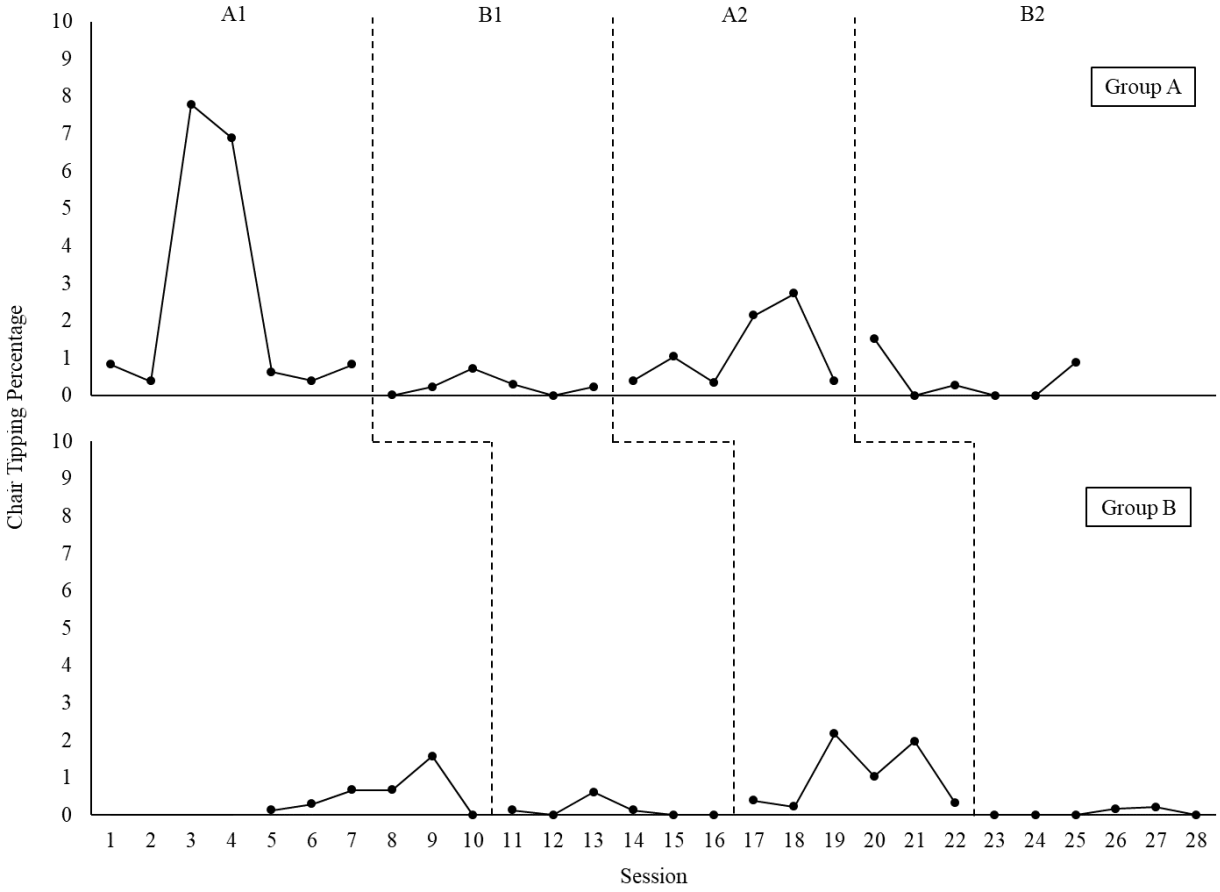

Table 4

Mean Percentage of Intervals during which Students displayed Chair Tipping across Conditions and Effect Sizes for Groups A and B

	Group A			Group B		
	Baseline (*n* = 13)	Intervention (*n* = 12)	Tau-U	Baseline (*n* = 13)	Intervention (*n* = 12)	Tau-U
Chair Tipping Percentage	1.90%	0.35%	-.76**	0.79%	0.10%	-.79**

In-Chair Movement

Mean in-chair movement levels across conditions are presented in Table 5. In-chair movement data was unavailable for sessions 4, 10, 17, and 22 for Group A, and sessions 7, 11, 22, and 23 for Group B, due to technological issues.

Table 5 shows that the mean in-chair movement levels increased during the intervention conditions for both groups, with a small non-significant increase for Group A (.23, $p = .39$) and a significant moderate increase for Group B (.64, $p < .05$).

Table 5

Mean In-Chair Movement Levels across Conditions and Effect Sizes for Groups A and B

	Group A			Group B		
	Baseline ($n = 11$)	Intervention ($n = 10$)	Tau-U	Baseline ($n = 10$)	Intervention ($n = 10$)	Tau-U
Movement Index	337.1	347.6	.23	365.1	405.4	.64*

Overall Movement

Mean overall movement levels for Classes A and B are presented in Table 6. Overall movement data was unavailable for the first half of data collection, with only data for phases A2 and B2 included.

Table 5 shows that the mean overall movement levels increased during the intervention conditions for both groups, with a small non-significant increase for Class A (.20, $p = .30$) and a significant moderate increase for Class B (.84, $p < .05$).

Table 6

Mean Overall Movement Levels in the Classroom across Conditions and Effect Sizes for Classes A and B

	Class A			Class B		
	Baseline ($n = 5$)	Intervention ($n = 5$)	Tau-U	Baseline ($n = 5$)	Intervention ($n = 5$)	Tau-U
Turbidity Index	.045	.048	.20	.061	.075	.84*

Environmental Variables

Mean levels of environmental variables across conditions for Classes A and B are presented in Table 8. Environmental data was unavailable for sessions 4, 10, 17, and 22 for Class A, and sessions 7, 11, 22, and 23 for Class B.

Table 8 shows that there were no significant differences between baseline and intervention levels for each of the environmental variables for both groups, indicating that they were not significant confounding variables in this study.

Table 8

Mean Classroom CO_2, Temperature, and Humidity Levels across Conditions and Effect Sizes for Classes A and B

	Class A			Class B		
	Baseline (*n* = 11)	Intervention (*n* = 10)	Tau-U	Baseline (*n* = 10)	Intervention (*n*=10)	Tau-U
CO_2	242 ppm	280 ppm	.26	281 ppm	263 ppm	-.32
Temperature	22.1 °C	21.1 °C	-.32	21.9 °C	22.0 °C	.08
Humidity	59.3%	56.0%	-.02	55.5%	56.3%	-.16

Social Validity Data

A total of 28 students completed the survey for Class A, and 26 for Class B. Participant responses are shown in Table 7.

Table 7 shows that 71.4% of students in Class A and 80.7% in Class B preferred the BodyfurnFlex chairs, while only 17.9% and 7.7% preferred the regular chairs. For students who preferred the BodyfurnFlex chairs, the most common reasons given were that they were more comfortable than the regular classroom chairs. Students revealed that the flexibility of the BodyfurnFlex chairs enabled them to easily adjust positions/postures, allowing them to get comfortable. In contrast, the regular classroom chairs restricted their movement, causing them to sit in uncomfortable positions. Additional reasons included that they felt softer, reduced pain, were easier to stack, and looked nicer than the regular chairs. Students who preferred the regular chairs reported that they found inflexible chairs more comfortable.

More than half of the students (57.1% in Class A and 57.7% in Class B) reported that they found it easier to complete their schoolwork when seated in BodyfurnFlex chairs, compared to 10.7% and 3.8% who found it easier in the regular chairs. Students who reported that the BodyfurnFlex chair made it easier to complete their schoolwork said that the increased comfort of the BodyfurnFlex chairs helped them to focus more on their work, which they felt made them more productive. Additionally, some students reported that the flexibility of the BodyfurnFlex chair enabled them to find the best position for the task they were doing. Students who felt that the regular chairs made it easier to complete their schoolwork reported being more comfortable in them, which helped them concentrate on their work. Meanwhile, one student commented that they found the flexibility of the BodyfurnFlex chair to be distracting.

Table 7

Participant Survey Responses for Classes A and B

		Which Chair Did You Prefer Sitting In?			Which Chair Did You Find It Easier to Complete Your Schoolwork In?		
Class	*n*	Regular	Bodyfurn	No Preference	Regular	Bodyfurn	No Difference
A	28	5 (17.9%)	20 (71.4%)	3 (10.7%)	3 (10.7%)	16 (57.1%)	9 (32.1%)
B	26	2 (7.7%)	21 (80.7%)	3 (11.5%)	1 (3.8%)	15 (57.7%)	10 (38.5%)

Discussion

The aim of this study was to examine how BodyfurnFlex chairs affected students' behaviour and movement in comparison to regular classroom chairs. The environmental conditions of the classroom were also monitored as potential confounding variables. Additionally, social validity data was collected to assess students' preferences and whether they felt the chairs made it easier to complete their schoolwork.

The findings of this study showed that BodyfurnFlex chairs had a significant effect on students' behaviour. The results demonstrated a clear functional relationship between the chairs and on-task behaviour, with the BodyfurnFlex chairs causing significant increases in on-task behaviour compared to the regular classroom chairs. This effect was replicated across two separate groups of

students from different classrooms, age groups, time periods, school subjects, and brands of regular chairs. The study also found that the mean frequency of disruptive behaviours decreased when students used BodyfurnFlex chairs, although this effect was only statistically significant for Group B. Additionally, BodyfurnFlex chairs resulted in sizeable decreases in two of the most common types of disruptive behaviours, chair tipping and out-of-seat behaviour.

The results of the participant survey further validated that the chairs affected students' behaviour. The majority of students stated that they found the BodyfurnFlex chairs to be more comfortable, which they felt enabled them to better focus and be more engaged in their schoolwork. This is consistent with research that shows that pain negatively affects attention (Moore et al., 2019) and improved physical comfort is associated with better engagement (Aga, 2024; Groenewald et al., 2020). Furthermore, considering that discomfort is a key reason for students engaging in chair tipping and out-of-seat behaviour (Knight & Noyes, 1999), the results suggest that by reducing discomfort, BodyfurnFlex chairs decreased the motivation for participants to engage in these disruptive behaviours.

The results also showed that both in-chair and overall movement in the classroom increased for both groups when students used BodyfurnFlex chairs; however, these increases were also only statistically significant for Group B. These findings are consistent with other research that found dynamic chairs increased the movement of occupants in comparison to traditional chairs (Grooten et al., 2017; Nüesch et al., 2018; Tanoue et al., 2016). However, unlike previous research, the current study was able to demonstrate this with students in a classroom setting over an extended period. Students revealed that the flexibility of the BodyfurnFlex chairs was the key factor behind their increased comfort, as it allowed them to easily change their postures and prevent discomfort. These findings are consistent with research that shows static sitting is associated with pain/discomfort (Caromano et al., 2015; Waongenngarm et al., 2015; Zemp et al., 2016), and that dynamic chairs can improve comfort (Frey et al., 2021; Garcia et al., 2016).

In conjunction, these findings suggest that by increasing students' movement, BodyfurnFlex chairs helped reduce the pain/discomfort associated with static sitting. Consequently, this enabled students to better focus on their work and eliminated the need for disruptive movements like chair tipping and out-of-seat behaviour as a way to alleviate discomfort.

The environmental data showed that there were no significant differences in CO_2, temperature, or humidity levels between baseline and intervention conditions for both groups, indicating that they were not confounding variables in the study. Additionally, the mean levels of CO_2, temperature, and humidity all fell within the Ministry of Education's guidelines for learning spaces (Ministry of Education, 2022), indicating they had a negligible impact on student behaviour in this study. Furthermore, the classroom setting and pedagogy remained consistent through data collection. Controlling these potential confounding variables significantly enhances the validity of the findings, indicating that the chairs did in fact have an effect on the behaviour and movement of students.

Research implications

This study fills an important gap in the literature by showing that, unlike other dynamic seating options, dynamic chairs can have a significant positive effect on student behaviour in mainstream classrooms. The findings also emphasise the importance of providing opportunities for movement in the classroom and suggest that it is essential for maintaining comfort and, consequently, helping students stay focused on their work and reducing disruptive behaviours such as out-of-seat behaviour and chair tipping. Furthermore, the results suggest that dynamic chairs could serve as an effective alternative to movement breaks for enhancing student behaviour without disrupting lessons or increasing the burden on teachers.

The findings of this study also have several socially significant implications. On-task behaviour has a significant positive correlation with students' academic achievement (Lei et al., 2018; Wong et al., 2024) and subjective well-being (Wong et al., 2024). Conversely, disruptive behaviour has a significant negative correlation with students' achievement (Blank & Shavit, 2016;

Finn et al., 1995) and is associated with teacher burnout, exhaustion, and job dissatisfaction (Kollerová et al., 2023; van den Brink et al., 2025). Additionally, chair tipping is a serious safety risk and is one of the leading causes of classroom injury (Salminen et al., 2014; van Dyne, 2010). Finally, in addition to causing pain/discomfort, prolonged static postures are linked with musculoskeletal disorders (MSDs) (soft tissue injuries affecting muscles, tendons, nerves, ligaments, joints, and blood vessels) (De Sio et al., 2018; Dong et al., 2022). Reducing static sitting postures and increasing movement may be an effective intervention for preventing the development of MSDs (Dong et al., 2022; Putsa et al., 2022). The results of this study indicate that by improving classroom behaviour and decreasing static sitting, BodyfurnFlex chairs could potentially have a positive effect on students' achievement and well-being, reduce teacher burnout and job dissatisfaction, and create a safer and healthier learning environment.

Research Limitations

One limitation of the study was the sampling method. Purposive sampling was used to select a representative sample from the classroom and avoid floor/ceiling effects. Although the researchers established the selection criteria, the teachers chose the participants, potentially introducing selection bias. Furthermore, while selecting middling/average students was beneficial for the study, it could limit the generalizability of the findings to the wider population. Specifically, students with learning difficulties or behavioural problems may particularly benefit from BodyfurnFlex chairs.

There were several limitations regarding the environmental and movement data. Connection issues with the Smart Classroom System meant that movement and environmental data were unavailable during several sessions. Additionally, in-chair movement data actually measured the movement of the chairs, not the students. However, chair movement is regarded as a good indicator of student movement and is often used in other research as a proxy for it (Grooten et al., 2017; Nüesch et al., 2018). Furthermore, the increase in overall movement during the intervention condition for both groups further validated that student movement indeed increased when they sat in BodyfurnFlex chairs.

It is also important to acknowledge that a functional definition was used for recording disruptive behaviour. Behaviours were only recorded as disruptive if they actually caused another student to stop their on-task behaviour or the teacher to stop teaching. Hence, it is unclear whether the frequency of disruptive behaviours decreased when students sat in BodyfurnFlex chairs or if students were simply less likely to be disrupted by another student's behaviour.

This study evaluated only the BodyfurnFlex chair, a specific design/brand of dynamic chair. While it showed that BodyfurnFlex chairs could improve student behaviour, these results should not necessarily be generalised to other types or designs of dynamic chairs.

Future Research

While the findings of this study show that BodyfurnFlex chairs can significantly improve student behaviours, it is important to investigate if these changes translate to any other socially significant outcomes. In particular, it would be beneficial to determine whether BodyfurnFlex chairs enhance the academic achievement of students compared to regular classroom chairs.

Conclusion

The current study addresses a significant gap in the existing literature regarding the impact of dynamic chairs on student behaviour. The findings suggest that dynamic chairs could be an effective intervention for reducing uncomfortable static sitting, thereby increasing engagement and reducing disruption in the classroom.

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Appendix: Participant Survey

Participant Survey

Q1. Which chair did you prefer sitting in?

- ☐ Regular Chair
- ☐ BodyfurnFlex Chair
- ☐ No Preference

Q2. Why did you select your answer for Q1?

Q3. Which chair did you find it easier to complete your schoolwork in?

- ☐ Regular Chair
- ☐ BodyfurnFlex Chair
- ☐ No Difference

Q4. Why did you select your answer for Q3?

Q5. Do you have any additional comments about the chairs or the study?

Chapter 5: Study 2

Active Sitting as an Intervention: The Effect of Movement on Student Behaviour

Study 2: Active Sitting as an Intervention: The Effect of Movement on Student Behaviour is an in-depth analysis of the movement and environmental data from Study 1, investigating potential correlations between the movement, environmental, and behavioural variables. As a result, several references to Study 1 appear throughout Study 2.

Introduction

Integrating movement into the classroom using movement breaks has been shown to significantly improve on-task behaviour (Broad et al., 2022; Goh et al., 2018; Kerpan et al., 2019; Mahar, 2011) and decrease disruptive behaviours (Camahalan & Ipock, 2015; McGowan et al., 2021; Moon et al., 2022; Wells, 2012). Although effective at improving students' behaviour, movement breaks require a break in the lesson (taking away from valuable learning time) and training for teachers on how/when to implement the breaks (Goh et al., 2018; Kerpan et al., 2019; Mahar, 2011). A potential way to integrate movement into the classroom without requiring a break in the lesson or teacher training is through active sitting. Dynamic chairs, which are designed to promote active sitting, have been shown to significantly increase in-chair movement in comparison to static (non-dynamic) chairs (Garcia et al., 2016; Grooten et al., 2017; Nüesch et al., 2018; Stanić et al., 2022; Tanoue et al., 2016), suggesting that they could have a positive effect on student behaviour. However, there is currently a lack of research into the relationship between in-chair movement and student behaviour. The large out-of-seat macro-movements associated with movement breaks (e.g., jumping jacks) are not directly comparable to the smaller in-chair micro-movements associated with active sitting. Hence, there is a need to investigate whether in-chair movement can improve students' behaviour.

Another key factor that may influence students' behaviour and warrants further investigation is the environmental conditions in the classroom. Despite extensive research demonstrating the significant effects of carbon dioxide (CO_2), temperature, humidity, and noise on students' attention, cognitive function, and performance (Aydin & Goktas, 2023; Cho, 2017; Haverinen-Shaughnessy & Shaughnessy, 2015; Fernandes et al., 2019; Shield & Dockrell, 2008; Woo et al., 2022), there is limited research into how these environmental variables relate to on-task and disruptive behaviours. Moreover, while noise can be environmental (e.g., air conditioning, electrical noise, traffic, weather), it can also be behavioural (e.g., students talking or making noise). Behavioural noise in the classroom is often viewed as a sign of off-task behaviour (Chapman et al.,

2023; Ludyga et al., 2022) and disruptive behaviour (Douglas et al., 2016; Olota, 2022), suggesting that BodyfurnFlex may also be able to reduce classroom noise levels.

In an effort to address these issues, Resero (Resero, n.d.), a New Zealand-based innovative furniture company, partnered with Callaghan Innovation (Callaghan Innovation, n.d.), a government agency that supports New Zealand businesses through R&D support and funding, to develop the Smart Classroom System. The Smart Classroom System is a network of sensors that monitor various environmental and movement variables and was designed to achieve two primary goals. First, to examine how different types of chairs influence student movement and behaviour. Second, to evaluate the environmental conditions in the classroom and their impact on student movement and behaviour. Furthermore, in addition to serving as a research instrument, the Smart Classroom System was developed as a potential evaluation and assessment tool to gauge classroom quality and provide feedback on learning environments. Although the Ministry of Education has strict guidelines on environmental conditions in learning spaces (Ministry of Education, 2022), research shows that many New Zealand classrooms fail to meet the required standards for learning (Building Research Association of New Zealand, 2019a, 2019b). These findings suggest there is a need for tools that can accurately assess environmental conditions in classrooms to ensure students have suitable learning spaces.

The aim of the current study was to utilise the Smart Classroom System to investigate the effect that BodyfurnFlex chairs had on student movement in comparison to regular classroom chairs, and how this movement was related to their behaviour (on-task, disruptive, out-of-seat, and chair-tipping). Two types of movement were recorded: in-chair motion (which included movement, acceleration, and rotation) and overall movement in the classroom. The Smart Classroom System was also used to examine whether BodyfurnFlex chairs affect classroom noise levels. In addition to measuring in-class noise levels (during class time), out-of-class noise levels (when the classroom was empty) were recorded to establish baseline noise levels and control for environmental noise. Additionally, we also monitored the environmental conditions (CO_2, temperature, and humidity) in

the classroom to explore potential associations between these variables and students' movement and behaviour.

Methods

Participants

Data was collected from two separate classrooms (Class A and Class B). Class A was an intermediate school maths class with a total of 31 students, aged 11-13 years. Class B was a secondary school English class of 29 students, aged 13-14 years. Overall movement, noise, and environmental data were collected for the entire classroom. In contrast, in-chair motion data (including movement, acceleration, and rotation) were collected for 10 students (the same 10 students from Study 1) in each of the two classrooms (Groups A and B). In-chair motion data were collected for only 10 students so they could be correlated with the behavioural data from Study 1, and because this is the current limit of the Smart Classroom System.

Materials

Chairs

Two types of chairs were used in the study: the regular classroom chairs and BodyfurnFlex chairs (as described in Study 1).

Smart Classroom System

The Smart Classroom system includes: 20 Nordic Thingy:52 sensors, two Raspberry Pi cameras and tripods, a laptop with the Smart Classroom Application (software), and a modem.

The Nordic Thingy:52 (Nordic Semiconductor, n.d.) is a compact, multi-sensor device designed to measure various movement and environmental variables. It features several sensors that monitor CO_2, temperature, and humidity levels. Additionally, it contains several motion sensors: an accelerometer that detects changes in velocity (i.e., acceleration), a gyroscope that measures changes in orientation (i.e., rotation), and a magnetometer that tracks changes in direction. Each of these sensors detects motion along three axes: the x-axis (horizontal or left/right), the y-axis (vertical or up/down), and the z-axis (depth or forward/back). Collectively, these three sensors enable nine-

axis motion sensing (three types of motion across three axes), providing a comprehensive measurement of the Thingy:52's movement. The sensors wirelessly connect to the laptop via Bluetooth.

The Raspberry Pi (Raspberry Pi, n.d.-b) is a single-board computer (a small computer built on a single circuit board), designed to be low-cost and versatile. The Raspberry Pis utilised in the Smart Classroom System were adapted to act as motion sensors by using the Raspberry Pi camera module (Raspberry Pi, n.d.-a). This add-on enables the Raspberry Pi to function as a camera. The Raspberry Pi cameras capture black-and-white video footage, which is then used to detect motion through a method called frame differencing. Frame differencing is a computer vision technique that identifies motion in video footage by comparing pixel changes between frames. Larger pixel changes from one frame to the next indicate greater movement or motion in the video. For example, a video of a person walking across the screen will cause significant pixel changes between frames, whereas a still image will produce minimal pixel changes. The Raspberry Pi cameras connect wirelessly to the laptop via the modem (i.e., the cameras connect to the modem, which in turn connects to the laptop), allowing movement data to be transmitted directly to the laptop.

The Smart Classroom App was developed by engineers at Callaghan Innovation using Python programming (Python, n.d.). The app is used to control the sensors remotely (i.e., start/stop recording), with data sent directly from the sensors to the app. The data is stored and organised into sessions, with each recording from start to stop considered one session. Users can download session data directly from the app in Excel spreadsheets, which include a complete list of every measurement and recording for each variable. Each measurement is timestamped, allowing users to select relevant data and exclude unrelated data (e.g., from specific time frames). The Thingy:52 sensors measure every 1,000 milliseconds (ms), while the Raspberry Pi cameras record every 500 ms. All variables recorded by the Thingy:52 sensors were converted to the group mean (i.e., the average value of all 20 sensors), while the Raspberry Pi motion data was averaged across both Raspberry Pi

cameras. Prior to data collection, all sensors were calibrated by the engineers to ensure accurate measurements.

Procedure

Design

A multiple baseline with ABAB reversal design was used in this study, alternating between baseline (regular chairs) and intervention (BodyfurnFlex chairs) conditions. Phase changes were made after several sessions of stable on-task behaviour (collected in Study 1) had been established.

Dependent Variables

The dependent variables in this study were in-chair movement, in-chair acceleration, in-chair rotation, overall movement in the classroom, noise levels, CO_2 concentration, temperature, and humidity.

In-chair movement was calculated by converting the nine-axis motion data into a movement index that indicates the size or magnitude of movement (i.e., displacement). This movement index is a ratio variable (i.e., an index of 0 indicates no movement, and an index of 2 signifies twice the movement of an index of 1). Like other ratio variables (e.g., weight, height, speed), there is no upper limit to this measure.

In-chair acceleration was calculated by converting the three-axis acceleration data into an acceleration index that represents the change in velocity (i.e., acceleration). Likewise, in-chair rotation was calculated using the three-axis rotation data and converted to a rotation index that represents the change in orientation (i.e., rotation). Both the acceleration and rotation indexes are also ratio variables.

Overall movement in the classroom was converted into a turbidity index, which represents the proportion of pixel changes from one video frame to the next, with a value of 0 indicating no pixel changes and a value of 1 indicating every single pixel changed.

Noise data was transformed into a sound index representing the noise level in the classroom. This was necessary because the standard measurement unit for noise or sound, decibels (dB), uses a

logarithmic rather than a linear scale (i.e., each unit indicates a multiplicative increase, not an additive one). This means that 100 dB is not twice as loud as 50 dB. Instead, sound 'doubles' with every 10 dB increase (for example, 60 dB is twice as loud as 50 dB). This can make calculating correlations and visual analysis both challenging and misleading.

CO_2 concentration, temperature, and humidity are all represented by their standard units of measurement: parts per million (ppm), degrees Celsius (°C), and percentage (%), respectively.

Setting

Classrooms were arranged in a traditional layout, with the teacher positioned at the front and students seated around tables. Two Thingy:52 sensors were attached to the 10 chairs of the selected participants (Groups A and B) in each classroom using Velcro patches (Velcro, n.d.). One sensor was placed under the seat, and the other on the back of the backrest, in the same location on each chair

The Velcro patches stayed on the chairs throughout data collection to ensure consistent sensor placement. The chairs were arranged around two adjacent tables, with five chairs at each. The two Raspberry Pi cameras were placed on tripods and set up in opposite corners of the classroom so that each camera could cover the other's blind spots. The classroom layout, including the arrangement of tables and cameras, remained the same throughout data collection.

Data Collection

Data were collected during regular class periods, with all equipment set up before each session and removed after each session. When students entered the classroom for their lesson, the researcher waited until all students were seated and checked that they were in the correct seats (i.e., the 10 selected students were in the designated chairs) before starting the recording. Only data from the first 25 minutes of each session (the same 25 minutes from Study 1) were included in the results. Data collection for Class A began two weeks prior to Class B. This was because there was a delay in obtaining consent from Class B, which was required before data collection could begin. Data were collected twice a week per classroom, for a total of 25 sessions for Class A and 24 for Class B.

Due to technical problems, several sessions contained corrupted or incomplete data and were therefore excluded from the results. A total of four sessions were excluded for both Class A (sessions 4, 10, 17, and 22) and Class B (sessions 7, 11, 22, and 23). Furthermore, the Raspberry Pi cameras were not operational during the first half of data collection, resulting in overall movement data being gathered only during the second baseline and intervention phases. Additionally, out-of-class noise levels (i.e., the noise level in the classroom when it was empty) were collected as probe data (i.e., intermittent readings/measurements to provide a snapshot) prior to several sessions to establish baseline noise levels and control for environmental noise. Determining how much the environment contributed to the overall level and variation of classroom noise was crucial to avoid falsely attributing changes in classroom noise levels to changes in student behaviour (when, in fact, they may be due to variations in environmental noise). Only out-of-class noise measurements lasting at least 5 minutes were included in the results.

Data Analysis

Each dependent variable was graphed throughout data collection, with each data point representing the mean value for that session. Visual analysis involved comparing the differences in trend, level, and variability of data between the baseline and intervention phases. Tau-U was used to calculate effect size, while Spearman's rank correlation coefficient was used to analyse relationships between variables. Data from both groups were pooled for the correlation analysis.

Results

In-Chair Movement

Mean in-chair movement for Groups A and B is presented in Figure 1 and summarised in Table 1.

Figure 1 shows that the Group A baseline in-chair movement levels (A1) remained very stable across all sessions (range: 322.1-361.1, *M* = 338.3). The introduction of the intervention (B1) coincided with a noticeable increase in the variability of in-chair movement (range: 278.2-424.8) and a small increase in the mean from the baseline (*M* = 356.6). The reinstatement of the baseline

conditions resulted in a return to the baseline mean (*M* = 335.6) and stable in-chair movement levels across all sessions (range: 327.5-345.5). The reintroduction of the intervention again coincided with increased variability in in-chair movement levels (range: 282.4-351.9), but did not cause a noticeable change in the mean (*M* = 338.6).

The Group B baseline levels of in-chair movement were relatively stable with a slight decreasing trend (range: 322.7-388.6, *M* = 345.9). The first intervention phase coincided with an immediate increase in in-chair movement (*M* = 416.7) and showed moderate variability with a slight increasing trend (range: 364.9-479.5). The return to baseline conditions coincided with a noticeable drop in in-chair movement level (*M* = 384.2), which was relatively stable across sessions (range: 353.2--406.5). The second intervention phase exhibited moderate variability in in-chair movement (range: 357.3-456.9), but resulted in only a small increase in the mean (*M* = 394.1).

Figure 1

Mean In-Chair Movement across Sessions for Groups A and B

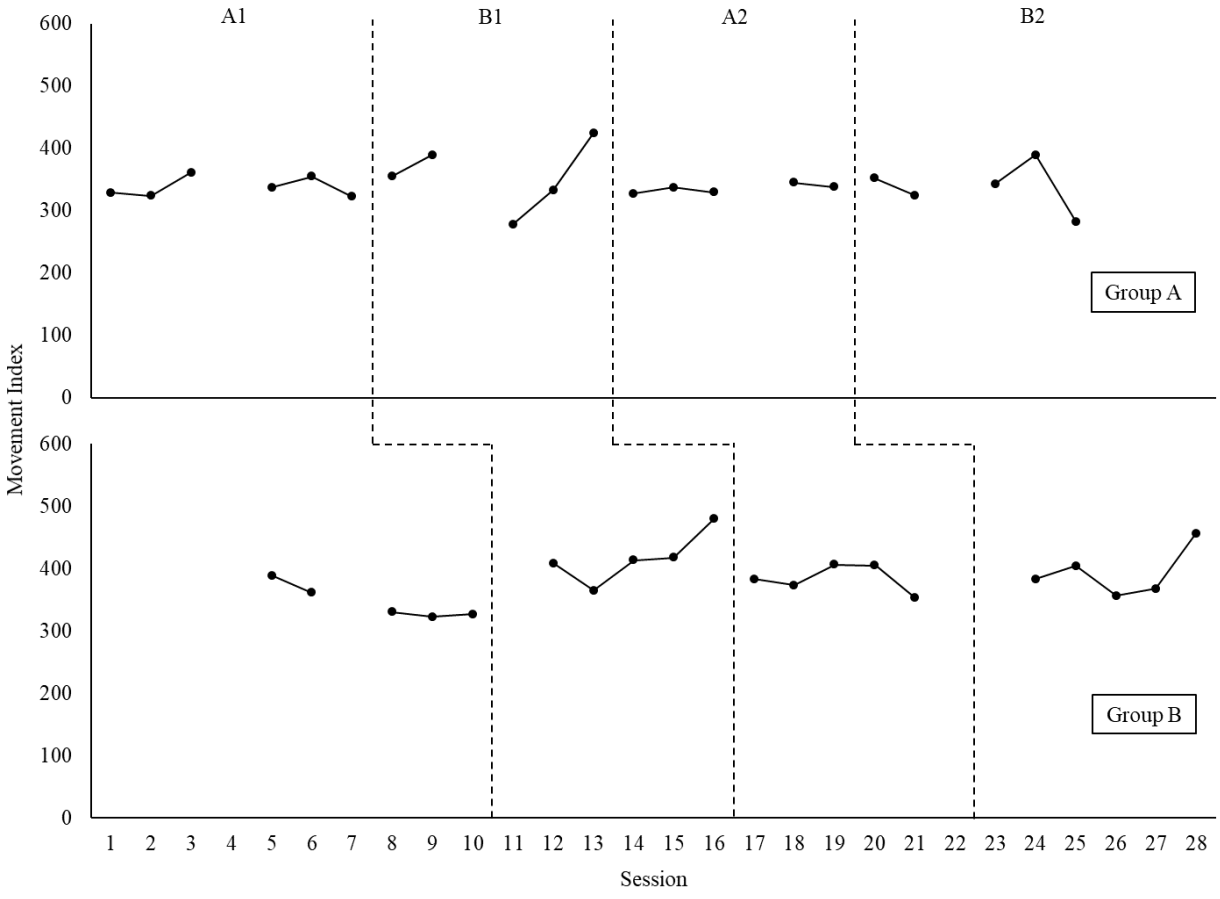

Table 1 shows that the mean in-chair movement levels increased during the BodyfurnFlex chair condition for both groups, with a small non-significant increase in Group A (.23, $p = .39$) and a significant moderate increase in Group B (.64, $p < .05$).

Table 1

Mean In-Chair Movement across Conditions with Ranges and Effect Sizes for Groups A and B

	Baseline		Intervention		
	M	Range	*M*	Range	Tau-U
Group A	337.1	322.1-361.1	347.6	278.2-424.8	.23
Group B	365.1	322.7-406.5	405.4	357.3-479.5	.64*

Note: *$p < .05$, **$p < .01$

In-Chair Acceleration

Mean in-chair acceleration for Groups A and B is presented in Figure 2 and summarised in Table 2.

Figure 2 shows that Group A's baseline in-chair acceleration levels were stable across sessions (range: 141.5-173.7; *M* = 155.0). The introduction of the intervention coincided with a small but noticeable increase in in-chair acceleration (*M* = 172.4) and, except for session 8, remained stable (range: 159.6-194.5). The second baseline phase was associated with a noticeable decrease in in-chair acceleration (*M* = 140.1), with all but one session (session 19) remaining below B1 levels (range: 116.9-180.5). In-char acceleration levels during the second intervention phase, except for session 25, were stable (range: 166.0-207.7) and showed a noticeable increase in mean (*M* = 177.9).

Group B baseline in-chair acceleration levels were relatively stable (range: 125.3-156.0, *M* = 144.3). The first intervention phase exhibited a moderate increasing trend (range: 175.3-253.0) and a noticeable increase in mean in-chair acceleration from the baseline (*M* = 199.3). The return of the baseline conditions coincided with a visible decrease in in-chair acceleration (*M* = 164.3), which showed moderate variability across sessions (range: 143.4-194.2). The second intervention phase exhibited some variability in in-chair acceleration levels (range: 167.0-219.4) and a noticeable increase in mean (*M* = 194.0).

Figure 2

Mean In-Chair Acceleration across Sessions for Groups A and B

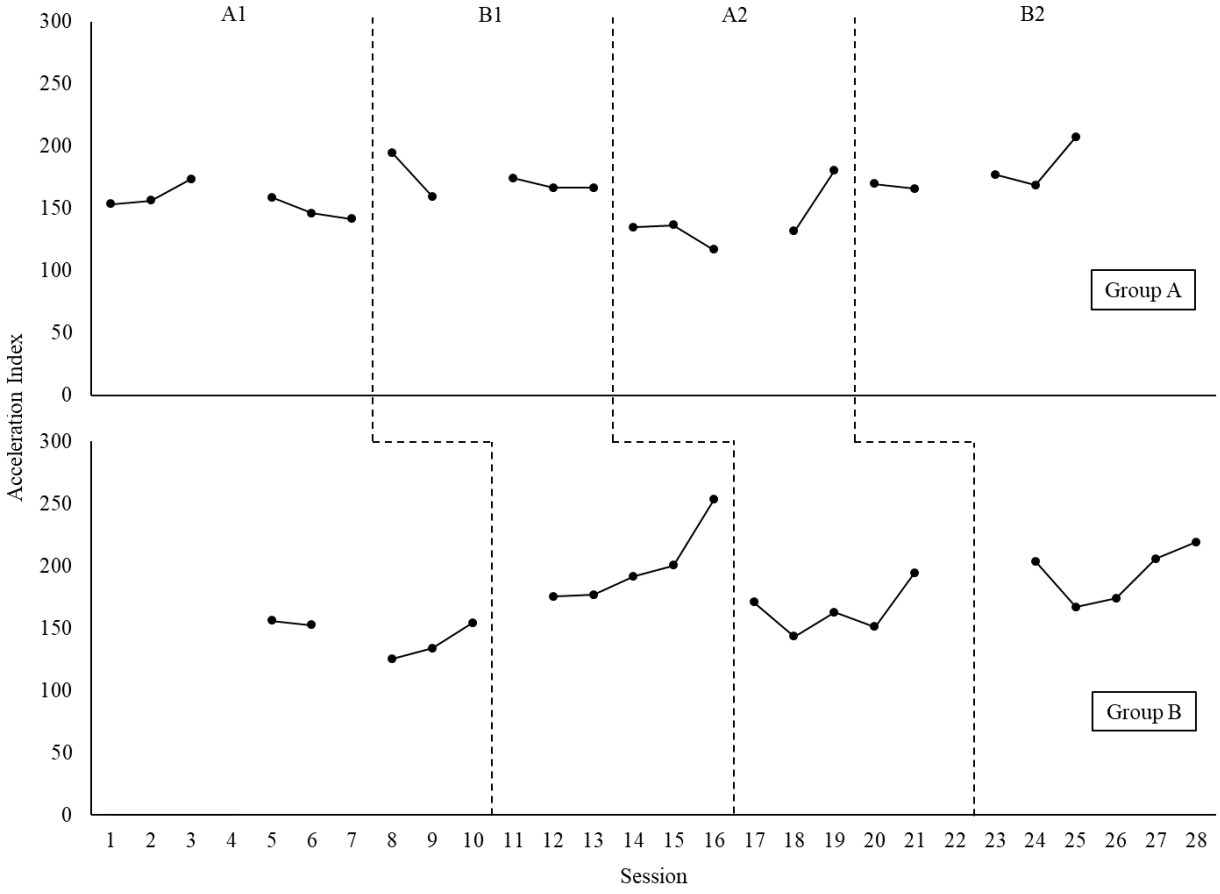

Table 2 shows that in-chair acceleration increased during the BodyfurnFlex chair condition for both groups, with a large, significant increase in Group A (.74, $p < .01$) and Group B (.88, $p < .01$).

Table 2

Mean In-Chair Acceleration across Conditions with Ranges and Effect Sizes for Groups A and B

	Baseline		Intervention		
	M	Range	*M*	Range	Tau-U
Group A	148.3	116.9-180.5	175.1	159.6-207.7	.74**
Group B	154.4	125.3-194.2	196.7	167.0-253.0	.88**

In-Chair Rotation

Mean in-chair rotation for Groups A and B is presented in Figure 3 and summarised in Table 3.

Figure 3 shows that Group A baseline in-chair rotation levels showed moderate variability across sessions (range: 185.6-239.0, *M* = 213.1). The first intervention phase also exhibited moderate variability in in-chair rotation levels (range: 133.8-205.1) but a decrease in mean from the baseline (*M* = 179.6). The second baseline phase continued to show moderate variability in in-chair rotation levels (range: 164.8-220.7) and a small increase in mean (*M* = 195.5). The reintroduction of the intervention again resulted in a decrease in mean in-chair rotation (*M* = 160.7), but no change in variability (range: 113.7-182.0).

The Group B baseline exhibited moderate variability in in-chair rotation levels across sessions (range: 195.8-249.6, *M* = 217.5). The introduction of the intervention resulted in a decrease in mean in-chair rotation (*M* = 199.6) and variability (range: 183.9-215.0). The reinstatement of the baseline conditions resulted in a return to the baseline mean (*M* = 215.9) and an increase in variability of in-chair rotation levels (range: 171.0-243.3). The second intervention phase also resulted in a decrease in both mean in-chair rotation (*M* = 202.0) and variability (range: 189.5-219.6).

Figure 3

Mean In-Chair Rotation across Sessions for Groups A and B

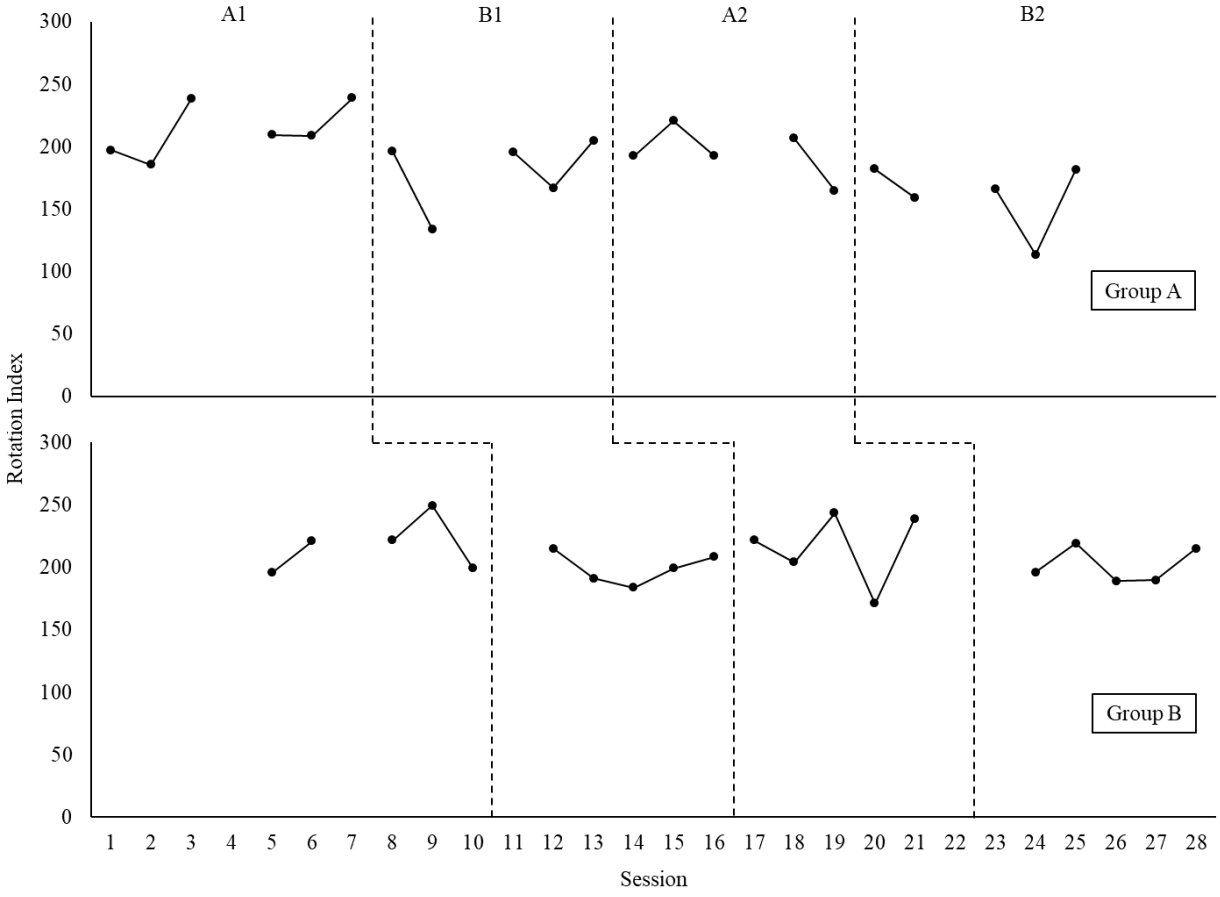

Table 3 shows that in-chair rotation decreased during the BodyfurnFlex chair condition for both groups, with a large, significant decrease in Group A (-.75, $p < .01$) and a non-significant decrease in Group B (-.52, $p = .05$).

Table 3

Mean In-Chair Rotation across Conditions with Ranges and Effect Sizes for Groups A and B

	Baseline		Intervention		
	M	Range	*M*	Range	Tau-U
Group A	205.1	164.8-239.0	170.2	113.7-205.1	-.75**
Group B	216.7	171.0-249.6	200.8	183.9-219.6	-.52

Overall Movement in the Classroom

Mean overall movement levels for Classes A and B are presented in Figure 4 and summarised in Table 4. Overall movement data were unavailable for the first half of data collection, so only data from the second regular and BodyfurnFlex chair phases were included.

Figure 4 shows that the baseline levels of overall movement for Class A showed moderate variability (range: .036-.058, *M* = .045). The intervention phase also showed moderate variability (range: .037-.057), with only a small increase in mean overall movement (*M* = .048).

The baseline overall movement levels for Class B showed a decreasing trend (range: .044-.069, *M* = .061). The introduction of the intervention was associated with a noticeable increase in overall movement (*M* = .075), which remained relatively stable across sessions (range: .068-.081).

Figure 4

Mean Overall Movement in the Classroom across Sessions for Classes A and B

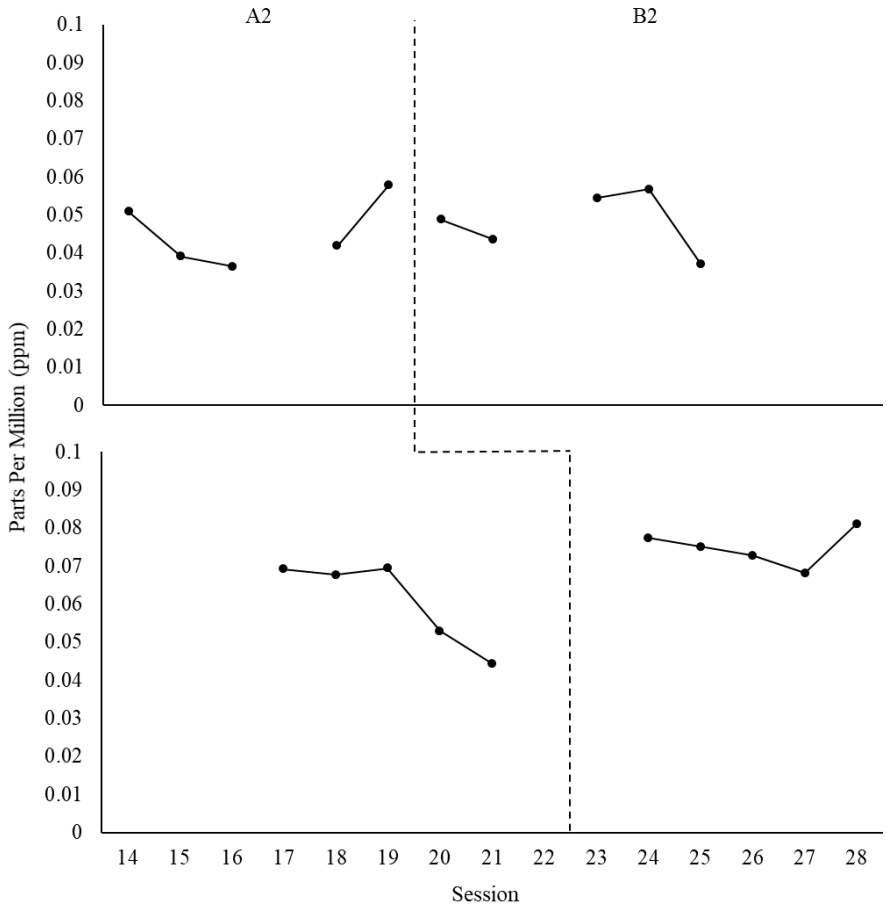

Table 4 shows that the mean overall movement levels increased during the BodyfurnFlex chair conditions for both groups, with a small, non-significant increase for Class A (.20, $p = .30$) and a large, significant increase for Class B (.84, $p < .05$).

Table 4

Mean In-Chair Rotation across Conditions with Ranges and Effect Sizes for Groups A and B

	Baseline		Intervention		
	M	Range	*M*	Range	Tau-U
Class A	.045	.036-.058	.048	.037-.057	.20
Class B	.061	.044-.069	.075	.068-.081	.84*

Noise

Mean out-of-class noise levels were recorded in sessions 1, 7, 11, 13, 14, and 21 for Class A and sessions 5, 9, 12, 17, and 27 for Class B (Table 5).

As shown in Table 5, the mean out-of-class noise levels for Class A were 36.4 and were relatively stable (range: 32.2-38.9), while the Class B mean out-of-class noise level was 46.7 and also remained relatively stable (range: 43.5-49.5).

Table 5

Mean Out-of-Class Noise Levels with Ranges for Classes A and B

	n	*M*	Range
Class A	6	35.4	32.2-38.9
Class B	5	46.7	43.5-49.5

Mean in-class and out-of-class noise levels for Classes A and B are presented in Figure 5, while in-class noise levels are summarised in Table 6.

Figure 5 shows that Class A baseline in-class noise levels showed moderate variability (range: 80.7-105.8, *M* = 91.3). During the first intervention phase, in-class noise levels were relatively stable (range: 70.8-86.7) and showed a decrease in mean from the baseline (*M* = 79.9). The return to baseline conditions resulted in a slight increase in mean in-class noise levels (M = 86.1) and some variability across sessions (range: 75.3-94.0). In-class noise levels from the second intervention

phase were also relatively stable (range: 81.2-91.5) but did not result in a noticeable change in mean (*M* = 87.5).

Class B baseline in-class noise levels were stable except for session 9 (range: 86.3-108.2, *M* = 102.3). The introduction of the intervention was associated with a noticeable decrease in in-class noise levels (*M* = 85.2) and, with the exception of session 14, remained stable across sessions (range: 74.7-90.3). The reinstatement of the baseline conditions resulted in an increase in mean in-class noise levels (*M* = 93.8) and variability (range: 80.8-103.2). During the second intervention phase, in-class noise levels stabilised (range: 91.7-101.5), and there was a small increase in the mean from A2 (*M* = 96.7).

Figure 5

Mean Classroom Noise Levels across Sessions for Classes A and B

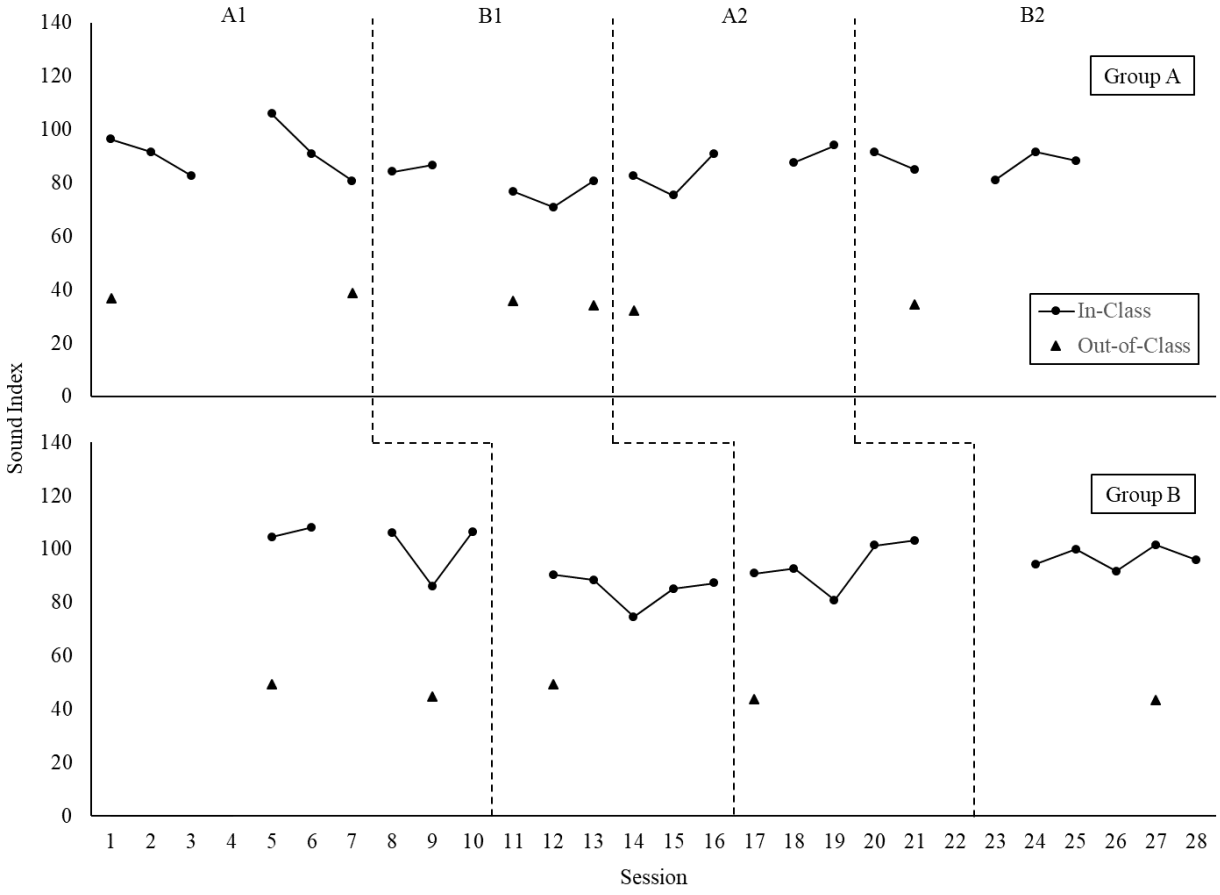

Table 6 shows that mean in-class noise levels decreased during the BodyfurnFlex chair condition for both classes; however, these decreases were small and non-significant for Class A (-.28, p = .29) and Class B (-.28, p = .30).

Table 6

Mean In-Class Noise Levels across Conditions with Ranges and Effect Sizes for Classes A and B

	Baseline		Intervention		
	M	Range	*M*	Range	Tau-U
Class A	88.9	75.3-105.8	83.7	70.8-91.5	-.28
Class B	98.1	80.8-108.2	91.0	74.7-90.3	-.28

Environmental Variables

The New Zealand Ministry of Education requires the daily average CO_2 concentration to stay below 1,250 ppm, while the classroom temperature and humidity must remain between 18-25 °C and 35-70%, respectively (Ministry of Education, 2022).

Carbon Dioxide (CO_2)

Mean CO_2 concentrations for Classes A and B are presented in Figure 6 and summarised in Table 7.

Figure 6 shows that Class A CO_2 levels during the first baseline phase were low (M = 243.8 ppm) and stable across sessions (range: 217.3-275.1 ppm). CO_2 levels during the first intervention phase remained stable (range: 206.5-370.7 ppm), except for session 9, and did not show a noticeable difference in mean from phase A1 (M = 257.3 ppm). During the second baseline phase CO_2 levels continued to remain stable (range: 217.6-283.1 ppm) with no visible change in mean (M = 240.6 ppm). The second intervention phase was associated with a slight increase in both variability (range: 221.6-395.7 ppm) and mean CO_2 levels (M = 303.2 ppm).

CO_2 levels during the first baseline phase for Class B were also very low (M = 291.8 ppm) and showed a very slight increasing trend (range: 249.4-356.5 ppm). During the first intervention phase, CO_2 levels also remained stable (range: 246.4-304.2 ppm), with a small decrease in the mean from phase A1 (M = 263.6 ppm). Except for session 18, the CO_2 concentration remained stable during the

second baseline phase (range: 241.6-349.9 ppm), with no noticeable change in the mean from B1 (*M* = 269.4 ppm). The second intervention phase continued to display low levels of CO_2 concentration (*M* = 261.7 ppm) that remained stable across sessions (range: 222.5-284.2 ppm).

Figure 6

Mean CO_2 Concentration across Sessions for Classes A and B

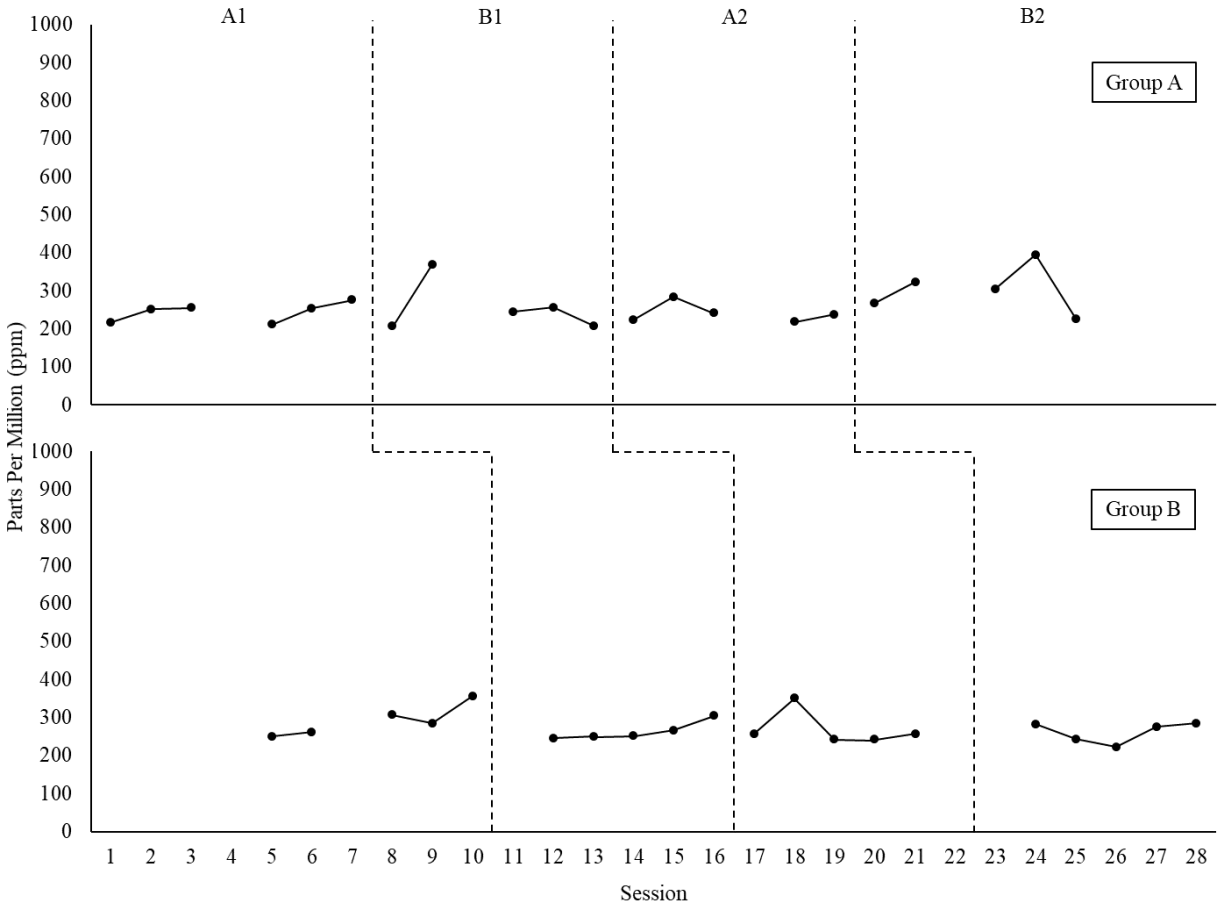

Table 7 shows that mean classroom CO_2 concentrations remained well below the required Ministry of Education limit of 1,250 ppm across all sessions, and there were no significant differences in mean CO_2 concentration between conditions for Class A (.26, *p* = .32) or Class B (-.32, *p* = .24).

Table 7

Mean Classroom CO_2 Concentration across Conditions with Ranges and Effect Sizes for Classes A and B

	Baseline		Intervention		
	M	Range	*M*	Range	Tau-U
Class A	242.4 ppm	217.3-283.1 ppm	280.2 ppm	206.5-395.7 ppm	.26
Class B	280.6 ppm	241.6-356.5 ppm	262.7 ppm	222.5-304.2 ppm	-.32

Temperature

The mean classroom temperature for Classes A and B is presented in Figure 7 and summarised in Table 8.

Figure 7 shows that classroom temperatures in the first baseline phase of Class A were stable, except for session 2 (range: 21.2-24.6 °C, *M* = 22.2 °C). During the first intervention phase, classroom temperatures remained stable (range: 18.8-22.9 °C), except for session 12, and showed a slight decrease in mean from A1 (*M* = 20.2 °C). Classroom temperatures during the second baseline phase remained stable (range: 21.5-22.8 °C) and showed a slight increase in mean (*M* = 22.1 °C). During the second intervention phase, classroom temperatures showed no noticeable change in level or stability (range: 20.8-23.0 °C, *M* = 22.0 °C).

Classroom temperatures during Class B's first baseline phase showed moderate variability across sessions (range: 20.2-24.6 °C, *M* = 22.1 °C). Temperatures during the first intervention phase continued to exhibit moderate variability across sessions (range: 18.3-23.3 °C), with no discernible change in the mean from A1 (*M* = 21.7 °C). There was no change in the mean classroom temperature during the second baseline phase (*M* = 21.6 °C), with temperatures remaining stable across sessions (range: 20.5-23.1 °C). There was a slight increase in mean classroom temperature during the second intervention phase (*M* = 22.8 °C), which displayed a moderate increasing trend (range: 18.9-25.9 °C).

Figure 7

Mean Classroom Temperature across Sessions for Classes A and B

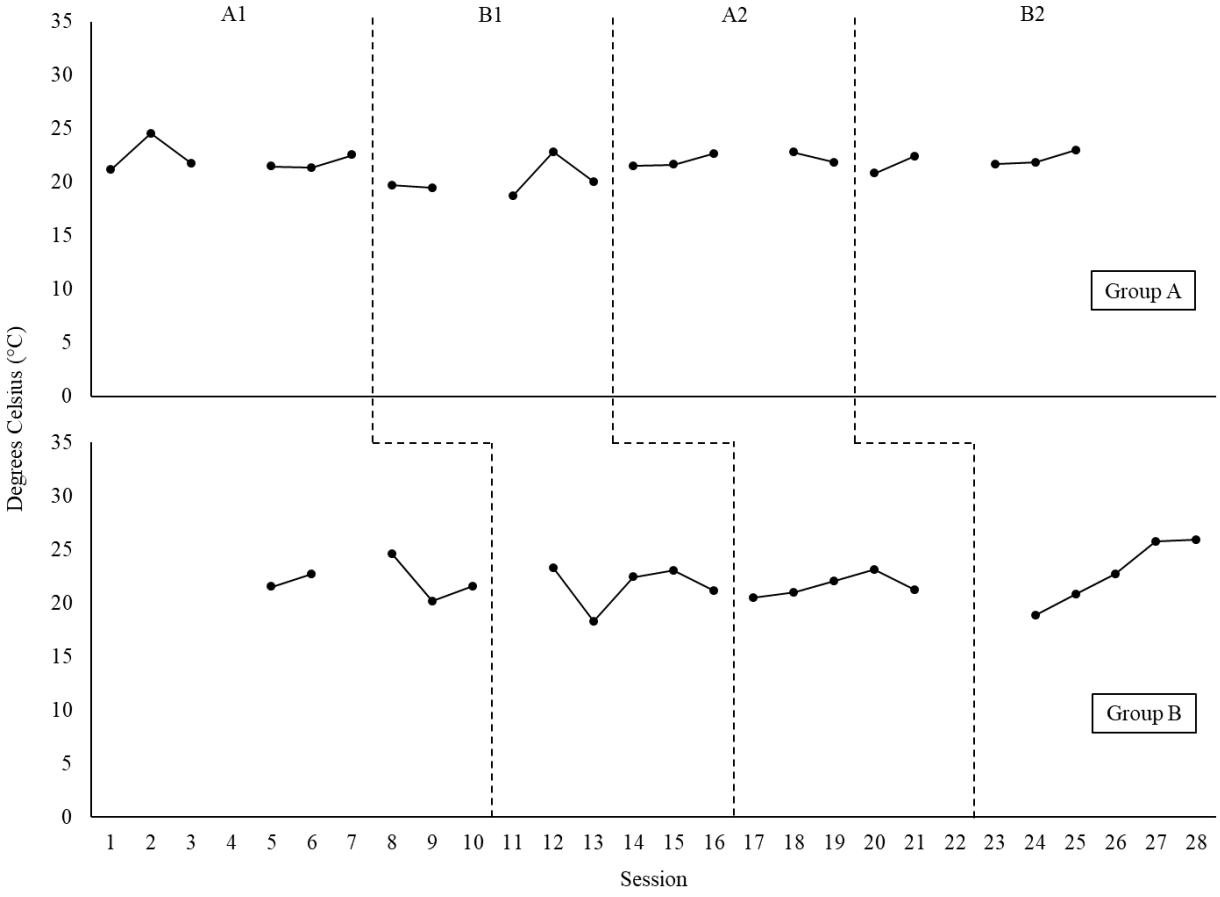

Table 8 shows that the mean classroom temperatures remained within the required Ministry of Education range of 18-25 °C across all sessions, and there were no significant differences in mean classroom temperature between conditions for Class A (-.32, p = .22) and Class B (.08, p = .77).

Table 8

Mean Classroom Temperature across Conditions with Ranges and Effect Sizes for Classes A and B

	Baseline		Intervention		
	M	Range	*M*	Range	Tau-U
Class A	22.1 °C	21.2-24.6 °C	21.1 °C	18.8-23.0 °C	-.32
Class B	21.9 °C	18.3-23.3 °C	22.0 °C	18.3-25.9 °C	.08

Humidity

Mean classroom humidity for Classes A and B are presented in Figure 8 and summarised in Table 9.

Figure 8 shows that classroom humidity during the initial baseline phase for Class A exhibited a high degree of variability across sessions (range: 42.0-75.4%, *M* = 58.3%). During the first intervention phase, there was moderate variability in classroom humidity levels (range: 43.2-69.6%), with no change in the mean from A1 (*M* = 57.6%). Classroom humidity during the second baseline phase exhibited a moderate decreasing trend (range: 44.6-69.0%); however, there was no change in the mean from B1 (*M* = 60.5%). During the second intervention phase, humidity showed moderate variability (range: 46.6-61.4%) and a slight reduction in mean from A2 (*M* = 54.4%).

Classroom humidity during the initial baseline phase of Class B remained relatively stable across sessions (range: 52.2-63.8%, *M* = 57.7%). There was no noticeable change in mean classroom humidity during the first intervention phase (*M* = 56.2%), which also remained fairly stable (range: 50.3-64.0%). Classroom humidity during the second baseline phase remained stable (range: 51.4-56.3%) with no notable change in the mean (*M* = 53.3%). The second baseline phase showed increased variability in classroom humidity levels (range: 50.0-65.1%), but again, there was no apparent change in the mean (*M* = 56.3%).

Figure 8

Mean Classroom Humidity across Sessions for Classes A and B

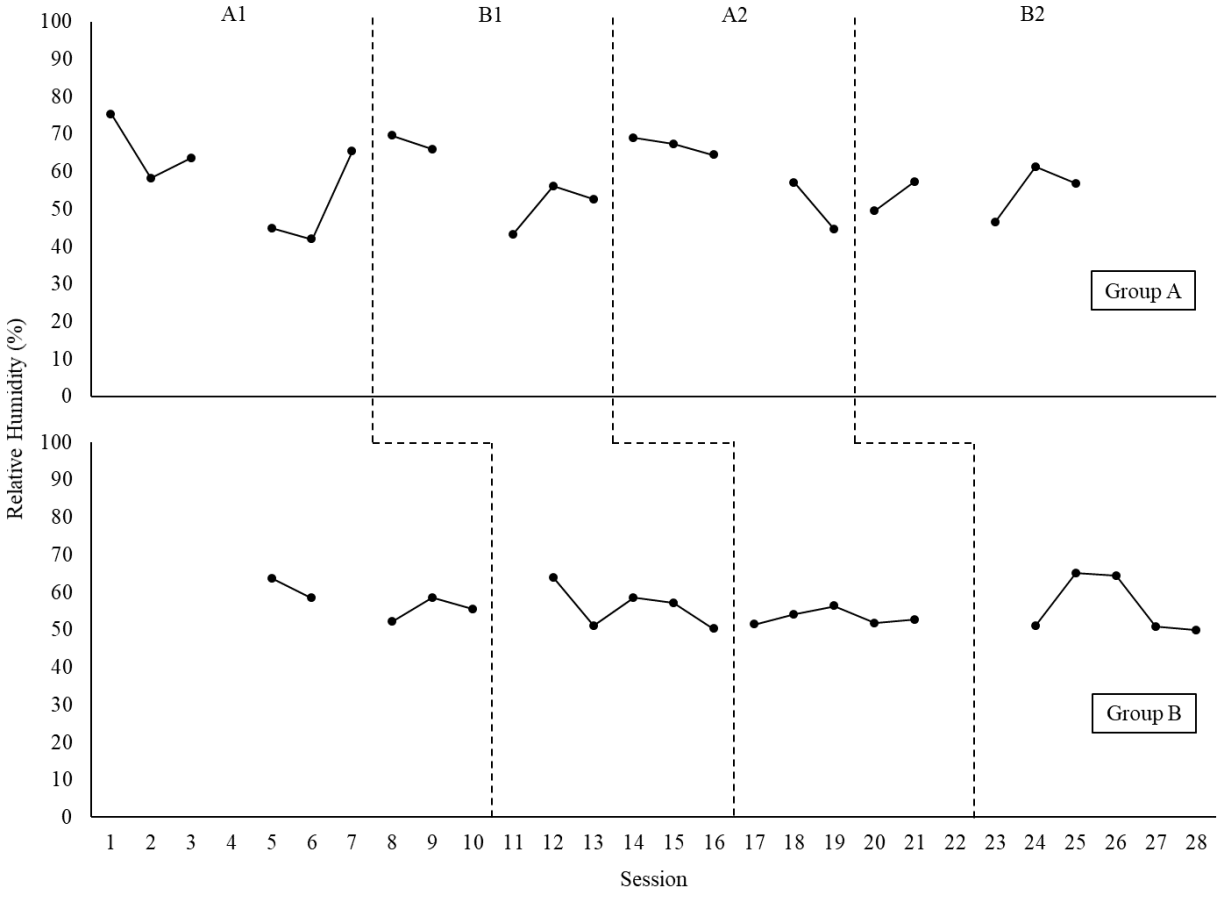

Table 9 shows that the mean classroom humidity remained within the required Ministry of Education range of 35-70% for all sessions, and there were no significant differences in mean classroom humidity between conditions for both Class A (-.02, p = .94) and Class B (-.16, p = .55).

Table 9

Mean Classroom Humidity across Conditions with Ranges and Effect Sizes for Classes A and B

	Baseline		Intervention		
	M	Range	*M*	Range	Tau-U
Class A	59.3%	42.0-75.4%	56.0%	43.2-69.6%	-.02
Class B	55.5%	51.4-63.8%	56.3%	50.0-65.1%	-.16

Correlations

A Spearman's rank correlation analysis was conducted to explore possible relationships between movement, environmental, and behavioural (collected in Study 1) variables. The results are presented in Table 10.

As shown in Table 10, several significant correlations were observed between variables. In-chair acceleration had moderate positive correlation with on-task behaviour ($r_s(39) = .62$, $p < .01$) and moderate negative correlations with out-of-seat behaviour ($r_s(39) = -.37$, $p < .05$) and chair tipping ($r_s(39) = -.46$, $p < .01$). Conversely, in-chair rotation had a large positive correlation with chair tipping ($r_s(39) = .56$, $p < .05$) and a moderate positive correlation with out-of-seat behaviour ($r_s(39) = .38$, $p < .05$). In-chair movement had large positive correlations with both in-chair acceleration ($r_s(39) = .51$, $p < .01$) and overall movement in the classroom ($r_s(18) = .53$, $p < .05$).

Additionally, on-task behaviour had moderate to large negative correlations with disruptive behaviour ($r_s(47) = -.56$, $p < .01$), chair tipping ($r_s(47) = -.38$, $p < .05$), and classroom noise levels ($r_s(47) = -.46$, $p < .05$). Meanwhile, chair tipping had a moderate positive correlation with disruptive behaviour ($r_s(47) = .30$, $p < .05$), and a large positive correlation with out-of-seat behaviour ($r_s(47) = .56$, $p < .01$). All three environmental variables (CO_2, temperature, and humidity) had small non-significant correlations with all other variables.

Table 10

Correlation Matrix

Variable	1	2	3	4	5	6	7	8	9	10	11	12
1. On-Task Behaviour	-											
2. Disruptive Behaviour	-.56**	-										
3. Out-of-Seat Behaviour	-.26	.21	-									
4. Chair Tipping	-.38*	.30*	.56**	-								
5. In-Chair Movement	.16	-.14	-.24	-.25	-							
6. In-Chair Acceleration	.42**	-.26	-.37*	-.46**	.51**	-						
7. In-Chair Rotation	-.39	.44	.38*	.56*	.33	-.23	-					
8. Overall Movement	.24	.19	-.30	-.41	.53*	.44	.22	-				
9. Noise	-.46*	.16	-.15	-.03	.06	-.06	.09	.44	-			
10. CO_2 Concentration	-.05	.17	-.16	-.20	.03	.03	.01	.19	.07	-		
11. Temperature	-.06	-.22	-.05	-.02	-.05	-.04	-.08	-.15	.14	.01	-	
12. Humidity	-.09	-.17	.05	.02	-.10	-.24	.06	-.22	-.21	-.14	.07	-

Note: *$p < .05$, **$p < .01$

Discussion

The aim of the current study was to investigate whether BodyfurnFlex chairs increased students' movement compared to regular classroom chairs and whether that movement was linked to their behaviour. Additionally, environmental factors (CO_2, temperature, humidity) and noise data were considered as potential confounding variables.

The results showed that in-chair movement increased for both Groups A and B when students sat in BodyfurnFlex chairs; however, this effect was only significant for Group B. These results are consistent with other research that found that dynamic chairs increase participants' movement compared to regular (static) chairs (Garcia et al., 2016; Grooten et al., 2017; Nüesch et al., 2018; Stanić et al., 2022; Tanoue et al., 2016). Furthermore, the results showed that there was noticeably more variation in the levels of in-chair movement across sessions during the intervention condition. One explanation for these findings could be that BodyfurnFlex chairs enable students to move as much as they need/want, depending on the task they were completing that session. In comparison, when seated in the regular chairs, students essentially move the same amount every lesson, regardless of the task or situation. However, the results did not find clear evidence to suggest that in-chair movement is associated with students' on-task or disruptive behaviour, with small, non-significant correlations between in-chair movement and all student behaviours.

The results also found that in-chair acceleration was increased when students were seated in BodyfurnFlex chairs, with a large positive effect in both groups. Considering that acceleration is the change in velocity (i.e., a higher mean acceleration tells us that an object's velocity is changing more frequently), the results suggest that on average students were moving more frequently/consistently when seated in BodyfurnFlex chairs in comparison to the regular classroom chairs (i.e., when the chair is not moving the velocity does not change, but when the chair is constantly moving the velocity will consistently change). Additionally, in-chair acceleration had a strong positive correlation with on-task behaviour and moderate negative correlations with out-of-seat behaviour and chair tipping. These findings suggest that consistent in-chair movement is

associated with increased engagement and a reduction in unproductive and disruptive movements, such as out-of-seat behaviour and chair tipping.

Conversely, in-chair rotation decreased when students used BodyfurnFlex chairs; however, this effect was only significant for Group A. Furthermore, in-chair rotation had a large positive correlation with chair tipping. Considering that rotation is the change in orientation (i.e., as an object rotates, its orientation changes), these findings suggest that in-chair rotation reflects large movements that alter the angle of the chairs (e.g., chair tipping. It is important to note that although the backrest and seat of the BodyfurnFlex chairs can pivot, these movements are minor and unlikely to cause significant changes in orientation, unlike chair tipping, which results in a substantial shift in orientation. In-chair rotation also had a significant positive correlation with out-of-seat behaviour. A potential reason for this could be that as students get out of their seats, they are required to move the chair (from under the desk), which could result in a substantial change in orientation (especially for the regular chairs, which cannot slide out like the BodyfurnFlex chair).

The in-chair motion data (movement, acceleration, and rotation) indicates that students not only moved more when seated in BodyfurnFlex chairs, but also more consistently. Furthermore, the results showed that the size or magnitude of in-chair movement was not significantly related to on-task behaviour, but the consistency of that movement (i.e., in-chair acceleration) was. These findings suggest that behavioural engagement is not related to how much students move but instead to how consistently they move. The results also indicated that students not only moved less (in both amount and consistency) when seated in the regular chairs, but the movement that they did engage in appeared to be large, unproductive, and disruptive movements, such as chair tipping and out-of-seat behaviour.

The overall movement data showed that classroom movement increased when students were seated in BodyfurnFlex chairs in both classes; however, this effect was only significant for Class B. Furthermore, a large positive correlation was found between overall movement and in-chair movement. These findings suggest that the in-chair movement exhibited by students when seated in

BodyfurnFlex chairs was substantial enough to result in a discernible increase in overall movement in the classroom.

The sound data showed that out-of-class noise levels remained substantially below the mean in-class noise levels across all readings. These results indicate that a substantial proportion of in-class noise was behavioural (i.e., from the students and teacher). Furthermore, out-of-class noise levels remained very stable across readings, whereas in-class noise levels showed moderate variation across sessions, suggesting that changes in in-class noise were due to behaviour rather than the environment. The mean in-class noise levels decreased when students were seated in BodyfurnFlex chairs; however, this effect was small for both groups. Although classroom noise is often seen as a sign of disruptive behaviour (Douglas et al., 2016; Olota, 2022), this study found no evidence to support this view, with a small, non-significant correlation between the two variables. However, there was a moderate negative correlation between noise and on-task behaviour. Given that the results indicate that a substantial portion of classroom noise was behavioural (i.e., generated by students), this finding supports the assertion that classroom noise is indicative of off-task behaviour (Chapman et al., 2023; Ludyga et al., 2022).

The environmental data revealed that mean classroom CO_2, temperature, and humidity remained within the New Zealand Ministry of Education guidelines of < 1,250 ppm, 18-25 °C, and 35-70% (Ministry of Education, 2022) across all sessions for both groups. Additionally, Tau-U showed that there were no significant differences in mean CO_2, temperature, or humidity between conditions for both groups. Furthermore, all three environmental variables had small, non-significant correlations with all other variables. These findings suggest that classroom CO_2, temperature, and humidity were not confounding variables in this study and did not significantly affect students' behaviour or movement.

Research Implications

Despite research showing that dynamic chairs can increase movement in comparison to regular (static) chairs (Garcia et al., 2016; Grooten et al., 2017; Nüesch et al., 2018; Stanić et al.,

2022; Tanoue et al., 2016), it has not been shown that this in-chair movement is associated with student behaviour. The results of the current study show that BodyfurnFlex chairs significantly improved the consistency of in-chair movement compared to regular classroom chairs, and that consistent movement while seated was associated with better on-task behaviour and reduced disruptive behaviour (namely, chair tipping and out-of-seat behaviour). These findings suggest that dynamic chairs could be an effective alternative to movement breaks for incorporating movement into the classroom. This would enable the behavioural benefits linked to movement integration, such as increased engagement (Goh et al., 2018; Kerpan et al., 2019; Mahar, 2011) and decreased disruptive behaviour (McGowan et al., 2021; Moon et al., 2022), without interrupting the lesson (which reduces valuable learning time) and requiring the teacher training associated with movement break interventions (Goh et al., 2018; Kerpan et al., 2019; Mahar, 2011

Aside from student behaviour, movement has several other crucial implications. Incorporating movement into the classroom has been shown to positively influence academic achievement (Donnelly & Lambourne, 2011; Petrigna et al., 2022; Shoval et al., 2018; Watson et al., 2017). Furthermore, prolonged static postures are associated with musculoskeletal disorders (MSD) (De Sio et al., 2018; Dong et al., 2022). In-chair movement and frequent postural changes have been shown to reduce musculoskeletal pain/discomfort (Akkarakittichoke et al., 2023; Arippa et al., 2022; Waongenngarm et al., 2021) and may be an effective intervention for preventing the development of MSDs (Dong et al., 2022; Putsa et al., 2022). The results of this study indicate that BodyfurnFlex chairs not only increase the amount of in-chair movement but also the frequency/consistency of that movement (suggesting frequent postural changes), indicating that they may be able to improve student comfort and help prevent the development of MSDs.

The study also demonstrated the use of a new potential tool for evaluating learning conditions in classrooms, in the form of the Smart Classroom System. CO_2, temperature, and humidity not only affect students' attention, cognitive functioning, and performance (Aydin & Goktas, 2023; Cho, 2017; Haverinen-Shaughnessy & Shaughnessy, 2015; Fernandes et al., 2019;

Shield & Dockrell, 2008; Woo et al., 2022) but can also have significant adverse health and social effects, including respiratory infections, allergies, headaches, fatigue, agitation, feelings of depression, and decreased school attendance (Angelon-Gaetz et al., 2016; Jaakkola et al., 2014; Mäkinen et al., 2009; Tu et al., 2021). Research has shown that many New Zealand classrooms do not fit within the required ranges for learning spaces (Building Research Association of New Zealand, 2019a, 2019b), indicating that many students are not only currently at a learning disadvantage but also at risk of adverse health outcomes. A tool like the Smart Classroom System could be a valuable resource for assessing the quality of learning spaces and identifying which classrooms require interventions (e.g., air conditioning, heating, cooling) to ensure students receive adequate, healthy learning environments.

Research Limitations

One limitation to consider is that the in-chair motion data measured the motion of the chairs, not the students. However, chair movement is considered a good indicator of student movement and is commonly used as a proxy for it in other studies (Grooten et al., 2017; Nüesch et al., 2018). However, including overall movement as a measure provided further evidence that students' movement (not just the chairs) indeed increased when they sat in BodyfurnFlex chairs. Overall movement increased in both groups during the intervention condition, and a large positive correlation was observed between in-chair movement and overall movement in the classroom.

Another limitation was that there was minimal variation in the environmental data, and the variation that did occur remained within the recommended ranges (i.e., indicating it did not affect the learning conditions). This meant that we were unable to gain insight into how the environmental variables influenced student movement and behaviour. However, this is also a positive aspect, as it means that the environmental variables measured in this study could be ruled out as potential confounders, adding further validity to the effect of the chairs on student movement and behaviour.

Future Research

Although the findings of this study suggest that BodyfurnFlex chairs may serve as a viable alternative to movement breaks for enhancing student behaviour, it should be noted that the effect size of movement breaks and dynamic chairs on student behaviour was not compared in this study. Considering that dynamic chairs do not require a break in the lesson, which takes away from learning time, they may be more effective than movement breaks at increasing the time students spend on task. Future research should consider comparing the impact of movement breaks and dynamic chairs on student behaviour.

Furthermore, considering that integrating movement into the classroom can improve students' academic achievement (Donnelly & Lambourne, 2011; Petrigna et al., 2022; Shoval et al., 2018; Watson et al., 2017), our results suggest that dynamic chairs, by promoting student movement, may also positively influence academic outcomes. Since academic achievement can significantly influence students' future quality of life (Edgerton et al., 2012; Starr et al., 2024), Interventions that enhance achievement are valuable and warrant further study.

Conclusion

The current study offers valuable insights into how dynamic chairs can influence student movement and addresses a gap in the existing literature on how this movement relates to behaviour. The findings suggest that BodyfurnFlex chairs could be an effective intervention for promoting student movement through active sitting and support the hypothesis that active sitting can enhance student engagement and minimise disruption in the classroom.

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Chapter 6: Study 3

The Effect of Dynamic Chairs on the Perceptions and Academic Achievement of Students

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The Effect of Dynamic Chairs on the Perceptions and Academic Achievement of Students

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Statements and Declarations

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Competing Interests

The authors declare that they have no competing interests.

Ethics Approval

The study received ethical approval from the University of Waikato Human Ethics Research Committee (Ref: FS2024-15).

Consent

Consent was obtained from participating teachers, students, and the parents/guardians of students.

Note

Callaghan Innovation (https://www.callaghaninnovation.govt.nz/).

Resero (https://www.reserogroup.com/). Resero is the parent company of Furnware (https://www.furnware.com/en-nz) who are the developers of BodyfurnFlex chairs.

Abstract

Recently, many schools have begun introducing dynamic seating options to enhance comfort and achievement. The current study investigated whether a new type of dynamic classroom chair, the BodyfurnFlex chair, could improve students' academic achievement and comfort compared with standard (non-dynamic) classroom chairs. A pre-post intervention between-groups design was used to track students' academic progression across several mathematics assessments, meanwhile focus group discussions were conducted to investigate participants' opinions of the chairs. The results revealed no significant difference in the median test grades between the control and intervention groups. However, several indications suggested that BodyfurnFlex chairs may have positively affected students' achievement, including a higher percentage of students in the intervention group improving upon their baseline grades. Students reported far greater satisfaction with BodyfurnFlex chairs, stating that they were more comfortable, functional, aided their ability to do their schoolwork, and felt they had a positive effect on their test results.

Keywords: dynamic chairs, academic achievement, flexible furniture, classroom comfort, student perceptions

Practitioner Summary

This study investigates the hypothesis that dynamic chairs can enhance students' comfort and, consequently, their achievement using a combination of quantitative and qualitative data. The results show that BodyfurnFlex chairs can increase student comfort and satisfaction, and may have a positive impact on academic achievement.

Introduction

Academic achievement plays a crucial role in enhancing an individual's overall quality of life (Edgerton et al., 2012; Starr et al., 2024). Higher academic performance is linked to better well-being (Nordlander & Stensöta, 2014), greater life satisfaction (Lettau, 2021), boosted self-esteem (Metsäpelto et al., 2020), expanded job opportunities and higher earnings (Hahn & Chattopadhyay, 2019; Lallukka et al., 2019), enhanced physical and mental health (Kosik et al., 2018; Lê-Scherban et al., 2014), promotion of economic growth (Heller-Sahlgren & Jordahl, 2024; Woesserman, 2016), and a decrease in crime rates (Lankester et al., 2025; Martins et al., 2022). A variety of personal/individual variables can affect academic performance, such as an individual's intelligence level (Lozano-Blasco et al., 2022; Roth et al., 2015), personality traits (Mammaddov, 2022), study habits (Elango & Manimozhi, 2021; Walck-Shannon et al., 2021), motivation (Kriegbaum et al., 2021), and attitude (Sölpük, 2017). While these personal factors can be difficult to change, there are numerous external/environmental factors related to academic achievement that can be modified. These include teaching style (López-Martin et al., 2023), the overall school and classroom climate (Erdem et al., 2024), and the physical learning environment (Barrett et al., 2015; Byers, Mahat, et al., 2018; Cheryan et al., 2014; Fadhli et al., 2022; Opio et al., 2024). Several aspects of the physical environment, such as the classroom noise levels (Brill & Wang, 2021; Shield & Dockrell, 2008), temperature and air quality (Cho, 2017; Haverinen-Shaughnessy & Shaughnessy, 2015), classroom layout and seating arrangements (Byers, Imms, et al., 2018; Imms & Byers, 2017; Nja et al., 2023), and lighting type/intensity (Heschong et al., 2002; Mogas-Recalde & Palau, 2021), have all been shown to significantly affect students' academic performance.

A key aspect of the physical learning environment is classroom seating (Al-Hinai et al., 2018; Chen & Tsai, 2024; Harvey & Kenyon, 2013; Knight & Noyes, 1999; Saarni et al., 2007; Trevelyan & Legg, 2011). Recently, many schools have started replacing traditional/standard chairs with dynamic/flexible seating options in an effort to enhance students' learning and comfort (Anderson & Hartley, 2018; Attai et al., 2021; Cole et al., 2021; Putman et al., 2024). Unlike standard classroom

chairs, which are usually inflexible and limit movement, dynamic seating encourages flexibility and promotes active postural changes. Several studies have compared the effects of dynamic seating options and standard classroom chairs on students' academic achievement (Fedewa et al., 2015; Joubert et al., 2017; Mead et al., 2016; Torbeyns et al., 2017). One study found that stability balls had no effect on the test scores of students in comparison to standard classroom chairs (Fedewa et al., 2015), while another found that they had a positive effect on a mathematics comprehension test but no effect on a mathematics academic progression test (Mead et al., 2016). Other studies have investigated the influence that cycle/bike chairs (a stationary chair with a bike pedal attached at the base which allows students to pedal while sitting at their desks) had on learning but found that they had no effect on the test scores of students in comparison to standard classroom chairs (Joubert et al., 2017; Torbeyns et al., 2017). After conducting a systematic review on the effects of dynamic seating interventions on academic outcomes, Rollo et al. (2017) concluded that there is currently no clear evidence that dynamic seating has a beneficial effect on the academic achievement of students. Rollo et al. (2017) also highlighted that dynamic seating other than stability balls and cycling chairs requires attention. While stability balls and cycle chairs are considered dynamic seating options (they promote and encourage movement) they are not directly comparable to dynamic chairs (an ergonomically designed chair that incorporates dynamic/flexible features). Furthermore, stability balls can negatively affect students' behaviour in mainstream classrooms, including reducing on-task behaviour and increasing disruptive behaviours (Fedewa et al., 2015; Hulac et al., 2020). Cycle chairs also present several shortcomings, including being uncomfortable (Fedewa et al., 2017), expensive (Torbeyns et al., 2017), and students having difficulty riding and engaging in class simultaneously (Polo-Recuro et al., 2021).

Research has shown that dynamic chairs can reduce discomfort/pain (Cardenas et al., 2024; Cardoso et al., 2021; Frey et al., 2021; Martin et al., 2025; O'Keeffe et al., 2013; Pennington & Putman, 2022; Synnott et al., 2017), increase movement (Garcia et al., 2016; Grooten et al., 2017; Léger et al., 2023; Martin et al., 2025; Stanić et al., 2022; Tanoue et al., 2016), and lead to better

satisfaction/perceptions of the learning environment (Attai et al., 2021; Martin et al., 2025; Pennington et al., 2022; Putman et al., 2024) in comparison to standard classroom chairs. Discomfort/pain can have a significant negative effect on academic achievement (Grimby-Ekman et a., 2018; Kosola et al., 2017; Ragnarsson et al., 2022; Voerman et al., 2017) while integrating movement into the classroom (Donnelly & Lambourne, 2011; Petrigna et al., 2022; Shoval et al., 2018; Watson et al., 2017) and better satisfaction/perceptions of the physical learning environment (Edgerton & McKechnie, 2023; Hopland & Nyhus, 2015; Opio et al., 2024; Salar et al., 2024) can have a significant positive effect on academic achievement. These findings indicate that students' academic outcomes could be significantly improved by dynamic chairs. Martin et al. (2025) found that BodyfurnFlex chairs (a dynamic chair) significantly increased student movement compared to standard classroom chairs, and the majority of participants preferred BodyfurnFlex chairs and found them more comfortable. Furthermore, BodyfurnFlex chairs significantly improved on-task behaviour and decreased disruptive behaviour of students in comparison to standard classroom chairs. These findings suggest that BodyfurnFlex chairs may be able to improve the academic achievement of students without the negative behavioural effects of stability balls and the discomfort/cost effects associated with cycle chairs.

The present study compared the effect that dynamic and standard classroom chairs had on the academic achievement of students. Academic achievement was measured by tracking the progression/improvement of students across several mathematics assessments. Furthermore, focus group discussions were conducted to gather social validity data from students and teachers. Social validity data is essential for determining the acceptability of an intervention and whether participants found it valuable (Common & Lane, 2017; Ferguson & Cihon, 2021; Huntington et al., 2023). This is important because even if learning interventions are effective, they are only useful if teachers and students are willing to use/implement them.

Methods

Participants

Six Year 9 mathematics classes, consisting of students aged 13-14, participated in this study. Three classrooms were randomly assigned to the control group and the other three to the intervention group. Test grades were collected from a total of 172 students, with 87 in the control group and 85 in the intervention group.

At the end of the study, we invited teachers and students from the intervention group to take part in focus groups to discuss their views on the classroom chairs. Three teachers and six students from the intervention classrooms (18 students in total) volunteered to participate in the focus group discussions (participants from the control group only experienced the usual classroom chairs so were not included).

Passive consent was obtained from all students and their parents or guardians prior to data collection. Parents and/or children could opt to have their test data excluded from the study. Additional signed consent was obtained from the teachers, students, and the parents of students who participated in the focus group discussions.

Materials

Classroom Chairs

The dynamic chair used in this study was the BodyfurnFlex chair (Furnware, n.d.). The chair has a sled base with separate polypropylene (plastic) backrest and seat panels that move/pivot with the user and include an aeration pattern for ventilation and cooling (Figure 1). The chair stands 872mm tall with a seat height of 460mm. The seat panel measures 416mm x 431mm, the backrest panel 374mm x 350mm, and the base area 495mm x 575mm.

The standard chair used in this study (Figure 2) was a monobloc polypropylene school chair, 805mm tall, with a seat height of 460mm. The dimensions of the seat, backrest, and base area were 365mm x 415mm, 400mm x 345mm, and 485mm x 510mm, respectively.

Figure 1

Dynamic Chair

Figure 2

Standard Chair

Assessment

Students were taught in accordance with the New Zealand Curriculum (Ministry of Education, n.d.-b) guidelines, as required by the Ministry of Education for all state schools in New Zealand. Data was collected for two separate mathematics subjects: Number and Algebra (Ministry of Education, n.d.-c). Students were assessed using e-asTTle (Ministry of Education, n.d.-a), an online assessment tool that assigns students a grade based on the New Zealand Curriculum level system. A student receives a grade based on their level (1-10) and sub-level (Basic, Proficient, and Advanced). Based on the students' age (13-14 years old), students were expected to receive a grade within levels 3-6, with students who failed to meet the minimum grade (Level 3 Basic) assigned a Developing grade (i.e., fail) and students who achieved above the maximum grade (Level 6 Advanced) assigned a Beyond grade.

Focus Group Discussions

A total of four focus group discussions were conducted, one with the teachers and one with the students from each of the three intervention classrooms. Several different prompt questions were created by researchers to facilitate the focus group discussions, these were; You have now had the opportunity to try out two different types of chairs/have two different types of chairs in your classroom, what are your impressions of them?, How do you feel that the different chairs affected your/the students' behaviour?, How do you feel the different chairs affected your/the student's ability to do their schoolwork?, What effect do you think the different chairs had on your/the student's test scores?, Do you have any other comments/feedback about the chairs or the study?.

Focus group discussions were recorded using an Android phone and then transferred to a password-protected computer for transcription. The audio recordings were transcribed using Otter.ai (Otter.ai, n.d.), an automatic transcription software, and then checked, edited, and analysed by one of the researchers.

Procedures

Dependent Variable

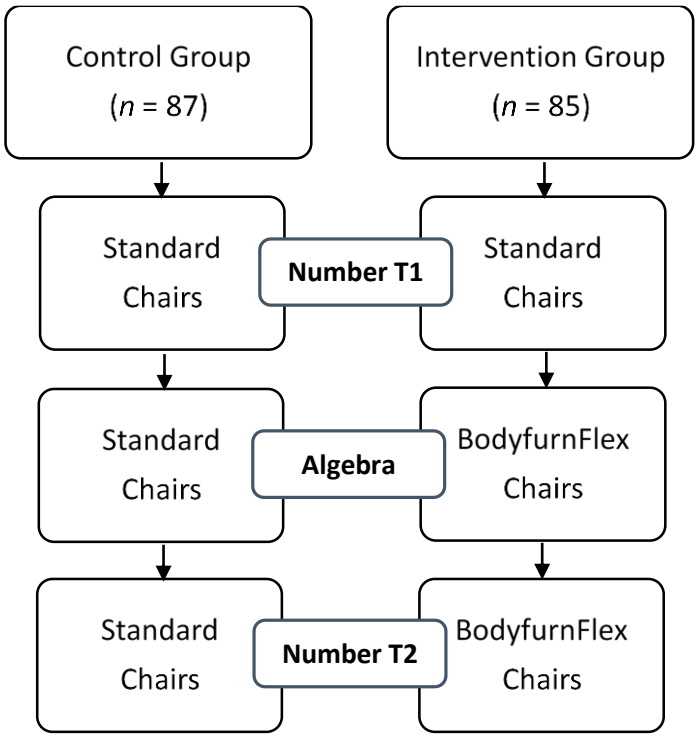
The dependent variable in this study was students' test grades. Three different grades were collected for each student: Number test 1 (T1), Number test 2 (T2), and Algebra.

Experimental Design

A pre-post intervention between-groups design was used to compare the progression of students' Number grades (from T1 to T2) for the control and intervention groups. Both groups used the standard classroom chairs during the baseline (pre-intervention) condition, after which the intervention group switched to the BodyfurnFlex chairs, while the control group continued to use the standard chairs. The Number T1 topic was taught during the pre-intervention condition, while Number T2 and Algebra were taught during the post-intervention condition (Figure 3).

Figure 3

Research Design



Data Collection

All classrooms followed the same learning and assessment schedule, being taught the subject material during the same time period and taking the e-asTTle test at the end of the teaching period (Table 1). Test grades were anonymised and shared with researchers after the completion of the final test (Number T2). Focus group discussions were conducted after the completion of the final test and were led by one of the researchers.

Table 1

Teaching Schedule

Subject	Start Date	End Date	Duration
Number T1	18 March 2024	5 April 2024	3 weeks
Algebra	22 July 2024	30 August 2024	6 weeks
Number T2	14 October 2024	1 November 2024	3 weeks

Coding of Data

Test grades were each assigned a numerical value for data analysis (Table 2).

Table 2

Test Grades and their Assigned Numerical Code

Grade	Code
Developing	0
Level 3 Basic	1
Level 3 Proficient	2
Level 3 Advanced	3
Level 4 Basic	4
Level 4 Proficient	5
Level 4 Advanced	6
Level 5 Basic	7
Level 5 Proficient	8
Level 5 Advanced	9
Level 6 Basic	10
Level 6 Proficient	11
Level 6 Advanced	12
Beyond	13

Data Analysis

The distribution of grades was presented using box-and-whisker plots for each test. The Mann-Whitney U test was used to compare grades between the control and intervention groups, while the Wilcoxon signed-rank test was used to compare T1 and T2 Number grades within each group. Key themes from the focus group discussions were summarised and supported with direct quotes.

Results

Number Grades

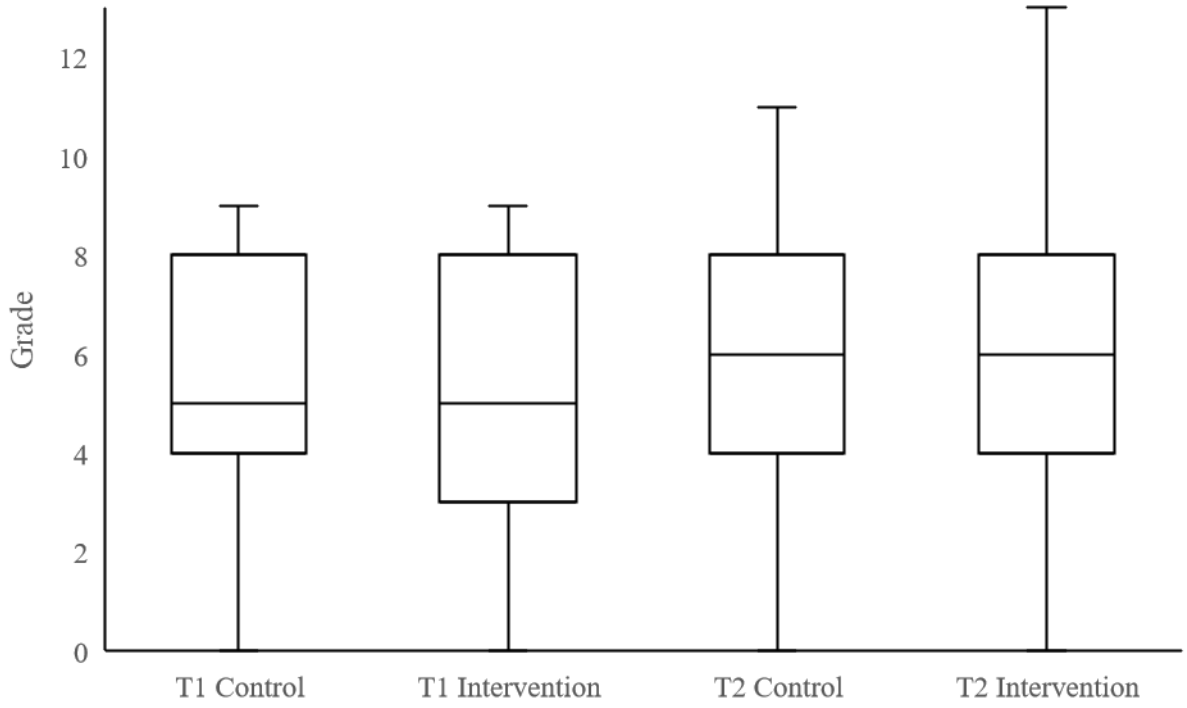
The distribution of the Number T1 and T2 grades for the control and intervention groups is displayed in Figure 4.

As seen in Figure 4, the Number T1 test, the control group had a median grade of 5 (IQR: 4-8) while the intervention group also had a median grade of 5 (IQR: 3-8). The Mann-Whitney U test revealed no significant difference in the Number T1 grades between the control and intervention groups (U = 3621, z = -0.24, p = .81, r = -0.02).

For the Number T2 test, the control group had a median grade of 6 (IQR: 4-8) while the intervention group also had a median grade of 6 (IQR: 4-8). The Mann-Whitney U test revealed no significant difference in the Number T2 grades between the control and intervention groups (U = 3654, z = -0.14, p = .89, r = 0.01).

Figure 4

Number T1 and T2 Grades for Control and Intervention Groups



The Wilcoxon signed-rank test revealed that there was a significant difference between the Number T1 and T2 grades for the control (z = -4.41, p < .01, r = .47) and intervention group (z = -5.02, p < .01, r = .54), with the control condition having a significant moderate positive effect on the academic progression of students while the intervention condition had a significant large positive effect on the academic progression of students.

The results also revealed that the percentage of students who improved on their baseline grade (i.e., progressed) was higher in the intervention group (64.7%) than in the control group (56.3%). Furthermore, the percentage of students who received a lower grade in Number T2 than in T1 (i.e., regressed) was higher in the control group (16.1%) than in the intervention group (12.9%) (Table 3).

Table 3

Academic Progression of Number Test Grades for Control and Intervention Groups

	Control (n = 87)	Intervention (n = 85)
Progressed	49 (56.3%)	55 (64.7%)
Regressed	14 (16.1%)	11 (12.9%)
No Difference	24 (27.6%)	19 (22.4%)

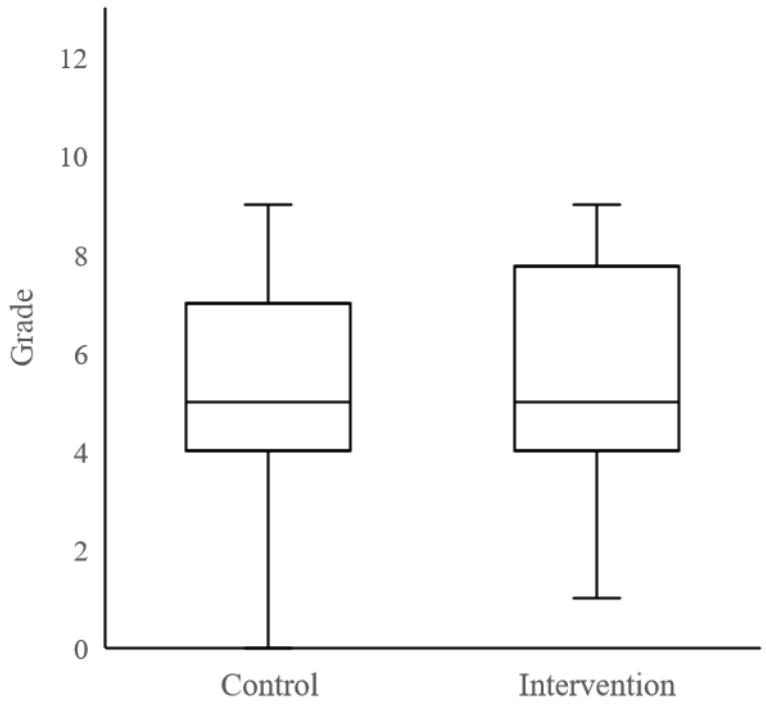
Algebra Grades

The distribution of the Algebra grades for the control and intervention groups is displayed in Figure 5.

As shown in Figure 5, the control group had a median grade of 5 (IQR: 4-7) for the Algebra test, while the intervention group also had a median grade of 5 (IQR: 4-8). The Mann-Whitney U test revealed no significant difference in Algebra grades between the control and intervention groups (U = 3241, z = -0.52, p = .60, r = 0.04).

Figure 5

Algebra Grades for Control and Intervention Groups



Focus Group Discussions

Comfort

All students agreed that they preferred the BodyfurnFlex chairs in comparison to the standard classroom chairs, with the key reason being that they were more comfortable. One student stated, “Those chairs (standard) are just, you know, hard and sore. But this one (BodyfurnFlex chair), you can just get comfortable straight away.” This sentiment was reiterated by the teachers, with one teacher stating, “When there was a changeover of chairs, they (students) did make a lot of comments about liking the new chairs (BodyfurnFlex) and them being more comfortable.”

Pain was a common reason given for why the standard chairs were less comfortable than the BodyfurnFlex chairs, with one student stating, “They (BodyfurnFlex chairs) don’t make my butt hurt, like the other chairs (standard).” Another student explained, “Those chairs (standard) are really stiff and hurt your back.”

The ventilation provided by the BodyfurnFlex chairs was another common reason given by students for finding them more comfortable. One student explained, “These kind of chairs (BodyfurnFlex) have the holes and are not as sticky. Usually I get sweaty and stick to the other (standard) chairs when it’s hot, but not with these ones.”. This sentiment was echoed by the teachers who felt that the ventilation of the BodyfurnFlex chairs was not only beneficial for improving student comfort but also for removing potential embarrassment. One teacher stated in reference to the BodyfurnFlex chairs,

> The breathability of the chair, in terms of having the holes, means that they (students) are not sticking to their chair and needing to peel themselves off. So, it provides more personal comfort and that little bit more protection of dignity by not having that “kerrr” (sound of peeling off chair) when they get out of the chair. So, I think definitely that creates a situation for a little bit more confidence within the class in terms of, okay, I don’t need to constantly lift and get out of my chair to ensure that does not happen.”

However, the flexibility of the BodyfurnFlex chairs was the most frequent reason given for finding them more comfortable. In reference to the standard chairs, one student explained, 'They're very uncomfortable, you can't move around in them and you have to hunch at your desk. But if you lean forward with the other chairs (BodyfurnFlex) it goes with you and supports you." The difference in movement/flexibility was also noticeable to the teachers, with one teacher stating: "I would say that they (students) definitely move a little bit more on these (BodyfurnFlex) chairs versus the normal (standard) ones."

Functionality

The functionality of the chairs was another theme that appeared throughout all the discussions. Several students mentioned that they found the sled base of the BodyfurnFlex chair to be beneficial for being able to slide in and out from under the desks and to adjust position when needed. Conversely, the standard chairs cannot slide and require the students to get out of the chair to move it. When referring to the BodyfurnFlex chairs, one student mentioned, "They are easier to slide out from under the desk, because the other ones (standard chairs) are quite hard to pull out, but these ones are quite smooth.".

One teacher also mentioned that the BodyfurnFlex chairs appeared to be more durable than the standard chairs. Noting that over time the standard chairs tend to bend out of shape when students rock on them, stating:

> "One thing I've noticed is that when students rock and play on them, especially the older heavier students, they bend. And so, within a couple years of having the chairs, they don't seem to last. So, then it creates this group of chairs that have been bent and you sit really awkwardly at a table. But I haven't noticed it (bending) happening to the new chairs (BodyfurnFlex)."

Effect on Schoolwork

The majority of the students, 14 out of 18 (77.8%), felt that the BodyfurnFlex chairs had a positive effect on their schoolwork in comparison to the standard classroom chairs. The other four

students (22.2%) stated that they felt that the chairs didn't make a difference, with no students feeling the standard chairs made it easier to do their schoolwork. The most common reason given was that the improved comfort of the BodyfurnFlex chairs helped them to better focus on their work. One student explained, "I feel like I could concentrate on my work more because I wasn't focused on my posture and I was actually comfortable."

One student mentioned that they were able to get more work done in the BodyfurnFlex chairs because they didn't feel the need to leave their seat, stating, "I've been doing much more work honestly, because my butt is not numb and I don't have the need to want to get up walk around as much." Another student stated that they were able to get more work done in the BodyfurnFlex chairs because they were less likely to fidget:

> "Yes, because I don't know about you guys, but I like to fidget a lot. Having that extra little bit of wobble in the fern (Bodyfurn) chairs, I don't really need to like, fidget with others things like a pencil."

Some students also felt that the BodyfurnFlex chairs were less distracting by not making squeaking noises like the standard chairs when their legs scrape on the floor as students moved in them, with one student stating, "They are good for when you get up, they are not too loud when you slide out (from under the desk), so it doesn't disturb others."

Conversely, there were some students that felt the chairs didn't make a difference to their ability to do their schoolwork, with one student stating, "No, I don't really think a chair can help with that (doing schoolwork)."

The teachers stated that they didn't notice any observable difference between the standard and BodyfurnFlex chairs effect on the students doing their schoolwork. However, they did feel that BodyfurnFlex chairs were beneficial, in theory, with one teacher stating:

> "I can't say that I have noticed any difference. But if you're more comfortable, that should increase your likelihood of how well you can sit and actually keep your focus. So, I think theoretically there should be at least a small improvement."

Effect on Test Grades

The majority of students, 12 out of 18 (66.7%), also felt that BodyfurnFlex chairs had a positive effect on their test grades, while the other six (33.3%) felt like they did not make a difference or were unsure. Of the students who felt the BodyfurnFlex chairs had a positive impact on their test grades, the consensus was that they felt they got more work done in the BodyfurnFlex chairs and that translated to a better grade, with one student stating, “Yeah, I got a better score when I used the Bodyfurn chairs, at the start (T1) I got a 3B and then when we did it again (T2) I got a 4A.”. When asked by the moderator why they thought that was, the student responded, “Because when you’re more comfortable you can just get more work done and learn better.” However, some students were unsure, with one student stating, “I got a better score (in T2), but I don’t know if that was because of the chair”.

The teachers were unsure whether the chairs made a meaningful impact on the test grades of the students with one teacher stating:

> “That's always a difficult question, because there's so many factors that go into learning. And it even comes down to, can we say that the student’s improvement over the year is because the chairs have changed? Or is it that, just in general, students improve throughout the year. We're meant to see improvement. Whether or not we can say that that is because of the chairs, it's hard to say.”

Discussion

The present study examined how BodyfurnFlex chairs impacted students' academic achievement and opinions/perceptions in comparison to standard classroom chairs. The results revealed that there was no significant difference in the grades between the control and intervention groups across all three tests, indicating that the chairs did not have a significant effect on the academic achievement of students. These results are consistent with other research that found dynamic seating options such as stability balls and cycle chairs had no significant effect on the test scores/grades of students (Fedewa et al., 2015; Joubert et al., 2017; Torbeyns et al., 2017). However,

several limitations to the data may have prevented finding significant results. Firstly, the New Zealand Curriculum employs a level grading system (Ministry of Education, n.d.-b) which can make detecting small changes/differences difficult (Cain et al., 2022; Guskey & Bailey, 2001; Micha et al, 2015). Secondly, on average students displayed very little progression in their test grades from Number T1 to T2, with both groups showing a median grade increase of only one sub-level (from Level 4 Proficient to Level 4 Advanced). Such small academic progression makes it unlikely for an intervention effect to be detected. And thirdly, the teaching periods for each topic were relatively short, with students only being taught the subject material for 3-6 weeks before for each test/assessment. The short time period that students experienced the intervention made it less likely for academic progression to be seen (Watson et al., 2017).

Despite this, there were several indications that the BodyfurnFlex chairs may have had a positive effect on the academic performance of students. Firstly, although both groups showed significant improvement in the median grade from T1 to T2, the Wilcoxon signed-rank test revealed that there was a larger z-score for the intervention group (z = -5.02, p < .01) than the control group (z = -4.41, p < .01), indicating a larger difference between the T1 and T2 medians for the intervention group. Secondly, the results revealed that there was a larger effect size for the intervention group (r = .54) than the control group (r = .46), indicating the BodyfurnFlex chairs had a large positive effect on the test grades of students while the standard chairs had a moderate positive effect. Finally, a higher percentage of students from the intervention group (64.7%) improved upon their T1 Number test grade compared to the control group (56.4%). Although small differences, these results indicate that BodyfurnFlex chairs may be able to have a small positive effect on the academic achievement of students.

The focus groups revealed that all students who participated in the discussions preferred the BodyfurnFlex chairs and found them to be more comfortable than the standard classroom chairs. These results are consistent with the findings of Martin et al. (2025) who also found the majority of students preferred BodyfurnFlex chairs over standard classroom chairs. A number of students stated

that the standard classroom chairs caused pain to their backside and/or back, which supports the current research that found dynamic/flexible seating options caused less pain and were more comfortable than traditional classroom chairs (Cardenas et al., 2024; Cardoso et al., 2021; Frey et al., 2021; Pennington et al., 2022). However, the most common reason given for why the BodyfurnFlex chairs were more comfortable was their flexibility. Students explained that being able to move and adjust positions freely enabled them to be more comfortable and better focus on their work. Considering that discomfort/pain are negatively associated with academic achievement (Grimby-Ekman et a., 2018; Kosola et al., 2017; Ragnarsson et al., 2022; Voerman et al., 2017) and students who express better perceptions/satisfaction with their physical learning environment have significantly better academic outcomes (Edgerton & McKechnie, 2023; Hopland & Nyhus, 2015; Opio et al., 2024; Salar et al., 2024), these findings support the hypothesis that BodyfurnFlex chairs could have a positive effect on the academic achievement of students in comparison to standard classroom chairs.

The majority of students (77.8%) reported that they felt the BodyfurnFlex chairs had a positive effect on their ability to do their schoolwork. A number of students mentioned that they felt they were able to get more work done in the BodyfurnFlex chairs for several different reasons, including; not feeling the need to leave their seat because of discomfort/pain, reducing fidgeting, and not being distracted by other students squeaking on the standard chairs. These findings are consistent with Martin et al. (2025) who found the majority of students reported that BodyfurnFlex chairs made it easier to complete their schoolwork and that BodyfurnFlex chairs resulted in a significant decrease in out-of-seat behaviour and instances of students being disrupted/distracted from their work. The majority of students (66.7%) also stated that they felt BodyfurnFlex chairs had a positive effect on their test results. Many participants stated that the BodyfurnFlex chairs were part of the reason why they received a better grade in the Number T2 test, feeling that because they could get more work done during class they were better prepared for the test. These findings

support the hypothesis that BodyfurnFlex chairs can make a meaningful impact on the learning and achievement of students in comparison to standard classroom chairs.

Research Implications

While there is research that examines the effect that alternative dynamic seating options such as stability balls (Fedewa et al., 2015; Mead et al., 2016) and cycle chairs (Joubert et al., 2017; Torbeyns et al., 2017) have on the academic achievement of students, there is currently no research on the effect that dynamic chairs have on the achievement of students (Rollo et al., 2019). This study fills an important gap in the literature by evaluating the effect that dynamic chairs have on the academic achievement, progression, and perceptions of students in comparison to traditional classroom chairs.

Although the results did not find any conclusive evidence that BodyfurnFlex chairs could significantly improve the test grades of students, there were several indications that they could have a positive effect on their academic achievement. Considering that better academic achievement is associated with significantly improved personal (Edgerton et al., 2012; Starr et al., 2024) and societal benefits (Heller-Sahlgren & Jordahl, 2024; Lankester et al., 2025; Martins et al., 2022; Woesserman, 2016), these findings suggest that BodyfurnFlex chairs could be an important tool/intervention.

In addition to academic achievement, musculoskeletal pain, which is a prevalent issue among students (Chambers et al., 2024; Gogoi et al., 2024; Kandasamy et al., 2024; Minghelli, 2020; Ogunlana et al., 2021), can also have a significant effect on students' quality of life and is associated with depression, physiological distress, and poor sleep quality (Alsaadi, 2022; Kitiş et al., 2017). Furthermore, student satisfaction is associated with better school involvement/engagement (Bălţătescu, & Cernea-Radu, 2025; Elmore & Huebner, 2010). The findings of this study suggest that BodyfurnFlex chairs may be able to improve student's quality of life and increase school engagement by reducing pain and improving student satisfaction.

Research Limitations

As discussed earlier, a key limitation in this study was the level grading system used to assess the students and the relatively short teaching periods before each test. Unfortunately, because all state schools in New Zealand are required to utilise this curriculum and assessment procedure (Te Kete Ipurangi, 2009), this left no room for the researchers to assess longer teaching periods and implement different assessment procedures such as percentage-based testing. Furthermore, the relatively limited academic progression shown by the students greatly limited the results of this study.

Another limitation was that there was no baseline data for the Algebra test. Because there was no pre-intervention test for Algebra, this meant that academic progression could only be analysed for the Number topic. Finally, only one school subject (mathematics), age group of students (13-14 years old), and type of dynamic chair were assessed during this study.

Future Directions

Considering that this study could not find any conclusive evidence that dynamic chairs can significantly improve the academic achievement of students, due to limitations around the data, the impact of dynamic chairs on the academic achievement of students requires further investigation. Future research should look to use percentage-based testing, longer teaching periods, and include different subjects/age groups of participants, in particular students with learning difficulties who have been shown to significantly benefit from dynamic seating interventions (Brennan & Crosland, 2021; Fedewa & Erwin, 2011; Krombach & Miltenberger, 2020; Matin Sadr et al., 2017; Schilling & Schwartz, 2004). Future research should also consider the use of progress monitoring tools/tests which are more likely to show improvement in academic achievement of short-term interventions than standardised tests which are not sensitive to short-term progress (Watson et al., 2017).

Conclusion

The study's findings suggest that BodyfurnFlex chairs may serve as a practical solution for enhancing student comfort, satisfaction, and overall learning experience by encouraging healthy

movement through active sitting. While the results did not provide strong evidence that these chairs directly impact students' test scores, there are hints that they might positively influence academic performance, which calls for further investigation.

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Chapter 7: General Discussion

In this thesis, I conducted a series of studies that investigated how dynamic chairs, specifically the BodyfurnFlex chair, affected students' behaviour and achievement, and why. As part of the current research, I sought to answer three main questions: Do dynamic chairs have a positive effect on students' behaviour compared with regular (non-dynamic) classroom chairs? How do dynamic chairs affect the movement of students in comparison to regular classroom chairs, and how is the movement related to students' behaviour? Do dynamic chairs have a positive effect on the academic achievement of students? This thesis included three distinct studies, each addressing one of the research questions.

In Study 1, I investigated the effect of BodyfurnFlex chairs on students' behaviour, movement, and perceptions compared with regular classroom chairs. Additionally, I monitored the environmental conditions in the classroom as potential confounding variables. In Study 2, I conducted a detailed analysis of the movement and environmental data collected in Study 1. This involved examining various aspects of the in-chair movement data, including acceleration and rotation, whether the chairs affected classroom noise levels, and exploring potential links between the movement, environmental, and behavioural variables. Finally, in Study 3, I explored whether the behavioural and movement benefits demonstrated by BodyfurnFlex chairs in the first two studies translated to improvements in academic achievement. Additionally, focus group discussions were conducted to gain a deeper understanding of teachers' and students' perceptions of the chairs and their influence on learning.

In conjunction, the key findings of these three studies showed that BodyfurnFlex chairs can improve students' on-task behaviour and reduce disruptive behaviours, including chair tipping and out-of-seat behaviour. These behavioural improvements were significantly associated with changes in student movement, specifically in-chair acceleration (i.e., consistent/frequent movement). Furthermore, the results showed that student behaviour was not associated with in-chair movement (i.e., displacement), indicating that students' engagement and disruptive behaviours are not related

to the size/magnitude of their movement but rather to how consistently they move. While I was unable to show that improvements in student behaviour translated into academic achievement, several key limitations, including the grading system, short teaching periods, and minimal academic progression, likely prevented us from detecting significant differences between conditions.

The findings of this research emphasise the importance of consistent movement as a fundamental human need that plays a crucial role in maintaining comfort and engagement. When individuals find themselves in situations where movement is restricted, such as being required to sit for extended periods without breaks, this increases the motivating operations to move. For students, this appears to manifest in off-task/disruptive movements, such as out-of-seat behaviour, chair tipping, and fidgeting. However, when this need for movement cannot be met, it can result in students struggling to focus/concentrate on their work due to discomfort. The results of this thesis suggest that dynamic chairs help to fulfil the basic human need for movement through active sitting, thereby reducing the motivating operations to engage in other types of movements (e.g., out-of-seat behaviour and chair tipping) and allowing students to focus on their work.

Implications for Research

The findings of this thesis also have important implications for future research. Other studies that have investigated the effect of dynamic chairs on movement have used different methods for measuring active sitting, including displacement (Grooten et al., 2017; Nüesch et al., 2018) and acceleration (Garcia et al., 2016; Stanić et al., 2022; Synnott et al., 2017; Tanoue et al., 2016). While both are measures of movement, they are not the same and should not be conflated. Displacement refers to how far something has moved (i.e., the size/magnitude of the movement), while acceleration is the change in velocity. However, while movement is a key part of active sitting, the size/magnitude of that movement is not. Active sitting is defined as maintaining consistent movement while seated through postural adjustments (Akkarakittichoke et al., 2023; Arippa et al., 2022; Hyeong et al., 2014). Considering that acceleration is the change in velocity (i.e., a higher mean acceleration tells us that an object's velocity is changing more frequently), this suggests that

acceleration is a more accurate measurement of active sitting than displacement. Furthermore, the current research demonstrates that not all movement is beneficial. While students moved less overall in regular chairs, they still exhibited significant movement. However, the movements they engaged in appeared to be large, unproductive/disruptive movements, such as chair tipping and out-of-seat behaviour. Future research should consider using acceleration as a measure of active sitting, rather than displacement.

Implications for Practice

This understanding of the necessity of consistent movement has important implications for the way we view other behaviour/movement interventions. Behavioural interventions such as differential reinforcement (Crewdson et al., 2023; Kirkpatrick et al., 2019), self-management strategies (Bulla & Frieder, 2018; Smith et al., 2022), and social stories (Ozdemir, 2008; Scattone et al., 2002) typically target the reduction of unproductive/disruptive movements like out-of-seat behaviour and chair tipping. Although effective at reducing undesired movement, these interventions target the consequence of static sitting. By restricting student movement, these interventions/strategies are preventing a fundamental human need for movement, which is likely to result in decreased engagement (due to discomfort) or, alternatively, in students engaging in other disruptive behaviours (e.g., fidgeting) to fulfil this need for movement. Conversely, dynamic chairs can be conceptualised as an environmental adaptation, an antecedent intervention that provides the opportunity for acceptable (non-disruptive) movement, thereby removing the motivating operation (i.e., static sitting) for these undesired behaviours and preventing them from occurring in the first place.

Most commonly, schools have looked to integrate movement into the classroom using movement/physical activity breaks (Gilmore et al., 2024; Turner & Chaloupka, 2017). However, while movement breaks have been shown to be effective at improving students' on-task behaviour (Broad et al., 2023; Mavilidi et al., 2020; Watson et al., 2017) and reducing disruptive behaviours (Broad et al., 2023; McGowan et al., 2021; Moon et al., 2022), they require a break in the lesson and additional

teacher training (Goh et al., 2018; Kerpan et al., 2019; Mahar, 2011). However, the current findings suggest that dynamic chairs offer an effective alternative to movement breaks, for meeting the basic need of movement and improving student behaviour, without requiring the lesson to stop (taking away from valuable learning time) or putting extra pressure on teachers to learn how to implement the breaks and find time to schedule them into their lessons.

The findings of this research also demonstrate that, unlike other dynamic seating options, dynamic chairs can positively influence students' behaviour in general education settings. When implemented in mainstream classrooms, both stability balls and cycle chairs have been shown to negatively affect students' behaviour (Fedewa et al., 2015; Fedewa et al., 2024; Hulac et al., 2020). A key reason for this is likely that neither stability balls nor cycle desks have been shown to promote active sitting. Erwin et al. (2016) found that stability balls significantly decreased students' in-chair acceleration compared to regular classroom chairs, indicating that they increased static sitting. Meanwhile, although cycle desks have been shown to increase students' energy expenditure and heart rate (Fedewa et al., 2017; Torbeyns et al., 2017), there is no evidence that they promote active sitting. Given that the seats and backrests of the cycle chairs are not dynamic (i.e., don't allow upper body movement), it is unlikely that they can promote active sitting (i.e., postural changes). These findings suggest that schools looking to introduce dynamic seating options should invest in dynamic chairs, rather than other dynamic seating options, such as stability balls and cycle chairs.

Social/Health Implications

The positive effects of BodyfurnFlex chairs shown in this research may also have other important social and health implications. In addition to reducing short-term pain/discomfort (Akkarakittichoke et al., 2023; Arippa et al., 2022; Waongenngarm et al., 2021), active sitting may be an effective intervention for preventing the development of MSDs (soft tissue injuries that affect the muscles, tendons, nerves, ligaments, joints and/or blood vessels) (De Sio et al., 2018; Dong et al., 2022). Given that MSDs are common in schools, impacting more than 1 in 4 students (Chambers et al., 2024), and that prolonged static sitting greatly contributes to this high prevalence (Harithasan et

al., 2022; Ogunlana et al., 2021), it is reasonable to assume that decreasing static sitting through the use of dynamic chairs could potentially lower MSD incidence in students.

Disruptive behaviour in the classroom is considered the primary social stressor that increases teaching demands (Kollerová et al., 2023) and is strongly linked to teacher burnout and job dissatisfaction (Otero-López et al., 2009; van den Brink et al., 2025; Vidić et al., 2021). Conversely, increasing on-task behaviour improves teacher-student relationships (Engels et al., 2016) and has a significant positive impact on students' subjective well-being (Wong et al., 2024; Zhu et al., 2019) and self-esteem (Karababa, 2020; Eryılmaz & Kara, 2025). Additionally, chair tipping presents a serious risk for classroom injury (Goss, 1992; Salminen et al., 2014; van Dyne, 2010), while out-of-seat behaviour can be a safety concern, particularly for young and disabled students (Cao et al., 2022; Flower et al., 2014; Pennington et al., 2012). The current research suggests that by improving students' on-task behaviour and reducing disruptive, out-of-seat, and chair tipping behaviours, dynamic chairs could potentially have a positive impact on the well-being of teachers and students while also creating a safer classroom environment.

The current research also introduced a brand-new tool, the Smart Classroom System. In addition to demonstrating that it can be an effective research tool for investigating different types of movement, the Smart Classroom System also offers a potential solution to the issue of the environmental conditions in New Zealand classrooms (Building Research Association of New Zealand, 2019a, 2019b). The ranges/limits for the environmental conditions set by the New Zealand Ministry of Education are not just recommended; they are required (Ministry of Education, 2022). However, currently, nothing is being done to enforce these requirements. Considering that the environmental conditions in classrooms have a significant impact on the learning (Haverinen-Shaughnessy & Shaughnessy, 2015; Liu et al., 2021; Wargocki et al., 2019; Wargocki et al., 2020) and health (Angelon-Gaetz et al., 2016; Jaakkola et al., 2014; Mäkinen et al., 2009; Tu et al., 2021) of students, tools like the Smart Classroom System could be of great value.

Strengths and Weaknesses

Due to the complex nature of analysing student movement, behaviour, and achievement, the current research was not without limitations. As previously mentioned, limitations to the test data greatly restricted the findings of Study 3. However, due to the structure of the New Zealand curriculum and grading system, I was left with little room to overcome these limitations. Secondly, purposive sampling was used in Studies 1 and 2 to minimise ceiling and floor effects. However, this may restrict the generalisability of the findings to the wider population, particularly students with behavioural issues who may find BodyfurnFlex chairs especially beneficial. Finally, due to connection issues, several sessions in Studies 1 and 2 contained incomplete sensor data, resulting in their exclusion from the results. Additionally, the Raspberry Pi motion cameras were not operational for the first half of data collection.

However, the current research also has a number of strengths that significantly enhance the quality and rigour of the findings. A key strength of this thesis was that I not only examined whether BodyfurnFlex chairs affected students' behaviour and outcomes, but also investigated why. This is important because if students' seating conditions are to be improved, it is crucial that we understand which aspects of the chairs actually make a difference, rather than investing in seating options that lack these features. Another strength of this thesis was the use of both data and methodological triangulation. In the first two studies, data were collected from two different classes, school subjects, age groups, timeframes, and types of regular chairs. Additionally, I employed multiple data collection methods, including observations, surveys, focus group discussions, and sensors. The current research also encompassed other aspects of the learning environment, including monitoring environmental conditions, maintaining consistent settings (e.g., classroom layout), and controlling for pedagogical outliers across sessions. Controlling these potential confounding variables significantly enhances the validity of the findings, indicating that the chairs did, in fact, affect students' behaviour and movement. Finally, as part of this research, I gathered extensive social validity data from students and teachers. This was important not only for

understanding how the chairs affected their behaviour but also for evaluating their acceptability. Ultimately, even if interventions are effective, they are only useful if both teachers and students believe they are helpful and are willing to use them.

Future Directions

As with all research, particularly single-case research, there is a need to replicate the results to enhance the generalizability of the findings. In addition, future research should explore the use of different types of dynamic chairs and include students with learning difficulties, who have been shown to benefit significantly from other dynamic seating interventions (Rollo et al., 2019). The current research also suggests that the effect of dynamic chairs on academic achievement warrants further investigation. The use of percentage-based testing or progress monitoring tools, along with longer-term data collection (at least a full year), should be considered to avoid the limitations of Study 3. Researchers may also want to consider studies that investigate the potential long-term social/health benefits of dynamic chairs, including their effect on MSDs, classroom injury, and student and teacher well-being. Finally, the findings of this research suggest that it is worthwhile to investigate the impact of dynamic chairs in settings beyond the classroom. Workplaces, particularly those that require prolonged sitting (e.g., office jobs), may greatly benefit from incorporating dynamic chairs, as conventional office chairs are typically not dynamic (Ellegast et al., 2012; Grooten et al., 2017). By promoting active sitting, dynamic chairs may help improve office workers' comfort, increase work engagement, and eliminate the need for microbreaks (short breaks used to break up prolonged periods of sitting by standing up and walking/stretching; Albulescu et al., 2022; Radwan et al., 2022).

Conclusion

In this thesis, I examined the effect of BodyfurnFlex chairs on students' behaviour, movement, comfort/perceptions, and achievement. Despite not finding conclusive evidence that BodyfurnFlex chairs can improve academic achievement, our findings provided strong evidence that they can significantly improve student engagement and reduce disruptive behaviours in the

classroom. The findings show that they effectively satisfy the basic need for movement through active sitting, reducing the need for unproductive movements such as chair tipping and out-of-seat behaviours. Overall, students reported far greater satisfaction with BodyfurnFlex chairs in comparison to regular chairs, stating that they were more comfortable, functional, aided their ability to do their schoolwork, and enabled them to be better prepared for their assessments.

Behavioural problems, such as disruptive and off-task behaviour, are a common problem in New Zealand classrooms, which are amongst the worst in OECD nations (Education Review Office, 2024). To address this issue, the Education Review Office has emphasised the need for interventions and strategies that target the underlying causes of these behaviours (Education Review Office, 2024). The current research suggests that dynamic chairs are not only an effective intervention for improving student behaviour, but also address a key underlying cause of disruptive/off-task behaviours, preventing them from occurring in the first place, without adding to teacher stress or workload.

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Appendices

Appendix A: Ethics Approval for Studies 1 and 2

Te Wānanga o Ngā Kete | ***Division of Arts, Law, Psychology & Social Sciences***

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THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Isaac Martin

Professor Nicola Starkey
Associate Professor Angelika Anderson

Te Kura Whatu Oho Mauri School of Psychology

11 November 2022

Dear Isaac

Re: **FS2022-61: An Experimental Evaluation of the Effect of BodyfurnFlex Chairs and Environmental Factors in the Classroom on the Movement and Academic Achievement of Students.**

Thank you for submitting your revised application to the ALPSS Human Research Ethics Committee. We have reviewed the final electronic version of your application and the Committee is now pleased to offer formal approval for your research activities as included therein.

We encourage you to contact the committee should issues arise during your data collection, or should you wish to add further research activities or make changes to your project as it unfolds. We wish you all the best with your research. Thank-you for engaging with the process of Ethical Review.

Kind regards

Dr Oleg Medvedev, Convenor
Division of Arts, Law, Psychology & Social Sciences Human Research Ethics

Appendix B: Ethics Approval for Study 3

Te Wānanga o Ngā Kete | ***Division of Arts, Law, Psychology & Social Sciences***

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Te Kura Whatu Oho Mauri
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THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Isaac Martin
im47@students.waikato.ac.nz

Dr Angelika Anderson
Professor Nicola Starkey

Te Kura Whatu Oho Mauri
School of Psychology

20 May 2024

Dear Isaac

Re: **FS2024-15: The Effect of BodyfumFlex chairs on the Academic Performance of Students**

Thank you for submitting your revised application to the ALPSS Human Research Ethics Committee. We have reviewed the final electronic version of your application and the Committee is now pleased to offer formal approval for your research activities.

We encourage you to contact the committee should issues arise during your data collection, or should you wish to add further research activities or make changes to your project as it unfolds. We wish you all the best with your research. Thank-you for engaging with the process of Ethical Review.

Kind regards,

Dr Oleg Medvedev, Convenor
Division of Arts, Law, Psychology & Social Sciences Human Research Ethics

Appendix C: Teacher Information Sheet and Consent Form – Studies 1 and 2

School of Psychology

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Information Sheet – Teachers

Associate Professor Angelika Anderson
School of Psychology
The University of Waikato
Phone: 07 838 4466 ext 9209
Email: angelika.anderson@waikato.ac.nz

PhD Student Isaac Martin
Phone: 0277148020
Email: im47@students.waikato.ac.nz

To whom it may concern,
You are invited to participate in a research project conducted by Isaac Martin, under the supervision of Associate Professor Angelika Anderson from the School of Psychology at the University of Waikato. This project is part of the requirement for the completion of my PhD in Behaviour Analysis at the University of Waikato. Please read this information sheet in full before deciding if you would like to participate in the project. If you have any questions about the project, please do not hesitate to contact me or Angelika via the contact details above.

What is the Project about?

The research project will focus on two aspects; the first will be to investigate how BodyfurnFlex Chairs affect the behaviour and learning outcomes of students in the classroom. BodyfurnFlex Chairs are a brand-new ergonomic chair designed to improve comfort and increase concentration. Information about the previous version of Bodyfurn chairs can be found at https://www.furnware.co.nz/products/bodyfurn/bodyfurn-sled-chair.

The second aspect of the project will explore how changes in certain environmental factors in the classroom, such as noise and air quality, affect the movement of students and alter the learning environment. This project will seek build upon the findings of my master's research project that was conducted in 2020. My master's thesis is available in the University of Waikato research commons https://researchcommons.waikato.ac.nz/handle/10289/14338.

What will be involved?

During the study, students will have periods where they sit in the BodyfurnFlex chair, and then at other times they will sit in the regular classroom chairs. This is so we can observe how the different chairs affect the student's behaviour, movement and learning. Data will be collected using video cameras (to record student behaviour), motion sensor cameras (to record overall movement in the classroom), and small sensors that will be attached to the chairs (to record in-chair movement and environmental variables). Equipment will be set up prior to class (e.g., before school or during break time) and in a way that does not interfere with learning. Cameras will be placed in the corners of the room, and the sensors attached to chairs are small (students will not be able to notice them while sitting in chairs). Data collection will take place during regular class time (approximately one-hour sessions) several days a week, at times that are most convenient for you. It is important to emphasise that data will be collected during regular classroom activities and will not interfere with the students' learning or education. The Project will take place over School Terms 2 & 3 (20 school weeks)

for approximately 5 months (April – September 2023). A data collection schedule can be organised that best fits in with your timetable. Efforts will be made to make as little disruption to the classroom as possible. However, at times, small changes to things such as the layout of the classroom/seating arrangements will likely be required.

What will your role be in the Project?

The behaviour and movement of the teaching staff is not being observed as part of the project. The role of the teachers is to replicate a normal learning environment and to conduct classroom activities as usual. However, the teaching staff is encouraged to give any input into what activities they feel would be best suited to the study and would work well in the designated learning environment.

Results

The results of the study will be reported in my final PhD thesis and potentially academic journal articles. Results may also be used in product advertisement for BodyfurnFlex chairs. Schools will be provided with a summary of the results and will also be notified whenever results are published (e.g., thesis or journal articles). The school will forward the summary of results to participants and notify you of any new publications. You may also contact the researchers directly to enquire about any results/publications.

Confidentiality

Any details of students and teachers will be treated with a high level of confidentiality and all data will be reported anonymously. No participants will be identifiable in the presentation of any results. None of the video footage will be published and will only be seen by the researchers involved for observation and data collection purposes.

Right to withdraw

Participation in this project is voluntary and all participants have the right to withdraw from the project at any time, even after signing a consent form.

What happens now?

If you would like to be a part of this project, please complete the consent form and return it to me. If you have any questions regarding the project, please do not hesitate to contact me at the details at the top of this form.

Sincerely,
Isaac Martin

This research project has been approved by the Human Research Ethics Committee of the Faculty of Arts and Social Sciences. Any questions about the ethical conduct of this research may be sent to the Secretary of the Committee, email alpss-ethics@waikato.ac.nz, postal address, Division of Arts, Law, Psychology and Social Sciences, University of Waikato, Te Whare Wananga o Waikato, Private Bag 3105, Hamilton 3240.

School of Psychology

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Consent Form – Teachers

Research Project: The Effect of BodyfurnFlex Chairs and Environmental Factors on the Behaviour and Movement of Students.

I _____ have received a copy of the Information Sheet describing the research project and have been given sufficient time to read it. Any questions that I have, relating to the research, have been answered to my satisfaction. I understand that I can ask further questions about the research at any time during my participation, and that I can withdraw my participation at any time. I understand that I can ask to have the observations stopped at any time. I understand that my identity will remain confidential in the presentation of the research findings.

Date:

Signature:

Appendix D: Select Students Information Sheet and Assent Form – Studies 1 and 2

School of Psychology

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Information Sheet – Select Students

Associate Professor Angelika Anderson
School of Psychology
The University of Waikato
Phone: 07 838 4466 ext 9209
Email: angelika.anderson@waikato.ac.nz

PhD Student Isaac Martin
Phone: 0277148020
Email: im47@students.waikato.ac.nz

Dear Student,
You are invited to be a part of a research project at your school. Isaac Martin is a student at the University of Waikato and is doing a study as part of his coursework under the supervision of Associate Professor Angelika Anderson. Please read the entire information sheet before deciding if you would like to take part in the project. If you have any questions about the project, you can ask Isaac, your teacher or ask a parent/caregiver to contact Isaac or Angelika.

What is the research about?

The research project will investigate if your regular classroom chairs or a new type of chair called BodyfurnFlex make it easier for you to do your schoolwork. BodyfurnFlex Chairs are a brand-new chair that is designed to increase comfort and make it easier for you to concentrate. Information about the previous version of Bodyfurn chairs can be found at https://www.furnware.co.nz/products/bodyfurn/bodyfurn-sled-chair.

We will also investigate if things like temperature and noise in the classroom make it more difficult for you to learn. I completed a similar project in 2020, which you can find using the following link: https://researchcommons.waikato.ac.nz/handle/10289/14338.

What will happen?

During the study, you will have periods where you sit in the BodyfurnFlex chair, and then at other times you will sit in the regular classroom chairs. This is so we can study how the different chairs affect your behaviour and learning. Video and sensor cameras will be set up in the corner of the room to record your movement and behaviour. Small sensors that measure movement and changes in environmental factors such as temperature, humidity, and noise will also be attached to your chair. These sensors are small, and you will not be able to notice them while you are sitting. Data will be collected during regular class time, several days a week. I will set up the equipment before class and you will continue your regular class activities as normal. The Project will take place over School Terms 2 & 3 (20 school weeks) for approximately 5 months (April – September 2023).

What will happen when the study is finished?

I will write a report about the results of the study as part of my university work. None of the video footage will be released and will only be seen by me. No personal details, like your name, will ever appear in the results or anywhere else. No one will be able to identify you in from this study. I will send the school a summary of the results and they will give you a copy of the results. If you want to know what happened in the study, you can ask me, your teacher or a parent/caregiver to contact me, and I will send you a summary of the results.

What if I don't want to be in the project?

Not taking part in the study will not affect your learning or experience in the classroom. Only certain sections of the classroom will be on camera, and only students who are participating in the project will be recorded. If you do not take part in the project, you will continue class as normal, and we will make sure you are not on camera. Participation in this project is always voluntary and you have the right to withdraw from the project at any time, even after signing a consent form. If at any time during the project you decide that you don't want to be in the study anymore, you can tell me, a teacher or a parent/caregiver, and you will be removed from the study and continue class as normal. You will have up to 3 weeks after the project finishes (end of term 3) to remove your data from the study.

What happens now?

If you would like to be a part of this project, please fill out the assent form and return it to your teacher or directly to me.

Sincerely,
Isaac Martin

This research project has been approved by the Human Research Ethics Committee of the Faculty of Arts and Social Sciences. Any questions about the ethical conduct of this research may be sent to the Secretary of the Committee, email alpss-ethics@waikato.ac.nz, postal address, Division of Arts, Law, Psychology and Social Sciences, University of Waikato, Te Whare Wananga o Waikato, Private Bag 3105, Hamilton 3240.

School of Psychology

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Active Assent Form – Select Students

Research Project: The Effect of BodyfurnFlex Chairs and Environmental Factors on the Behaviour and Movement of Students.

I _____ have read and understand the attached Information Sheet describing the research project. Any questions that I had about the study have been answered. I understand that I can stop participating in the project at any time. I am happy for the researcher to use the data collected during the project for their research as described in the Information Sheet. I understand that my identity will be kept hidden from the results of the study, and that my name will never be mentioned in any report.

Please complete the following checklist. Tick [✓] to indicate your response.	**YES**	**NO**
I want to take part in this research project.		
I agree to be recorded on video camera during this study.		

Date:

Signature:

Appendix E: Parents of Select Students Information Sheet and Consent Form – Studies 1 and 2

School of Psychology

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Information Sheet – Parents/Guardians of Select Students

Associate Professor Angelika Anderson
School of Psychology
The University of Waikato
Phone: 07 838 4466 ext 9209
Email: angelika.anderson@waikato.ac.nz

PhD Student Isaac Martin
Phone: 0277148020
Email: im47@students.waikato.ac.nz

Dear Parents/Guardians,
Your child has been chosen to participate in a research project conducted by myself, Isaac Martin, under the supervision of Associate Professor Angelika Anderson from School of Psychology at the University of Waikato. This project is part of the requirement for the completion of my PhD in Behaviour Analysis at the University of Waikato. Please read this information sheet in full before deciding if you consent to your child participating in the project. If you have any questions about the project, please do not hesitate to contact me or Angelika via the contact details above.

What is the research about?

The research project will focus on two aspects: the first will be to investigate how BodyfurnFlex Chairs affect the behaviour and learning outcomes of students in the classroom. BodyfurnFlex Chairs are a new ergonomic chair, designed to improve comfort and increase concentration. Information about the previous version of Bodyfurn chairs can be found at https://www.furnware.co.nz/products/bodyfurn/bodyfurn-sled-chair.

The second aspect of the project will explore how changes in certain environmental factors in the classroom, such as noise and air quality, affect the movement of students and alter the learning environment. This project will seek to build upon the findings of my master's research project, which was conducted in 2020. My master's thesis is available in the University of Waikato research commons:
https://researchcommons.waikato.ac.nz/handle/10289/14338.

What will be involved?

During the study, students will have periods where they sit in the BodyfurnFlex chair, and then at other times they will sit in the regular classroom chairs. This is so we can observe how the different chairs affect the student's behaviour, movement and learning. Data will be collected using video cameras (to record student behaviour), motion sensor cameras (to record overall movement in the classroom), and small sensors that will be attached to the chairs (to record in-chair movement and environmental variables). Equipment will be set up prior to class (e.g., before school or during break time) and in a way that does not interfere with learning. Cameras will be placed in the corners of the room and the sensors attached to chairs are small (students will not be able to notice them while sitting in chairs). Data collection will take place during regular class time (approximately one-hour sessions) several

days a week. It is important to emphasise that data will be collected during regular classroom activities and will not interfere with the students' learning or education. The Project will take place over School Terms 2 & 3 (20 school weeks) for approximately 5 months (April – September 2023).

What will happen with the Results?

The results of the study will be reported in my final PhD thesis and potentially academic journal articles. Results may also be used in product advertisement for BodyfurnFlex chairs. The school will be provided with a summary of the results and will also be notified whenever results are published (e.g., thesis or journal articles). The school will provide participants with a summary of the results and will notify participants of any new publications. You may also contact the researchers directly to enquire about any results/publications.

Confidentiality

Any details of students and teachers will be treated with a high level of confidentiality and all data will be done reported anonymously. No participants will be identifiable in the presentation of any results. None of the video footage will be published; it will only be seen by the researchers involved and will be used for observation and data collection purposes only.

What if I don't want my child to take part in the study?

Not taking part in the study will in no way affect your child's learning or experience in the classroom. Only certain sections of the classroom will be on camera and only students who are participating in the project will be recorded. Students who do not take part in the project will continue class as normal, and we will make sure they are not on camera. Participation in this project is voluntary and all participants have the right to withdraw from the project at any time, even after signing a consent form. You will have up to three weeks after the conclusion of the project (end of term 3) to request to have your student's data removed from the study.

What happens now?

If you are happy for your child to be a part of this project, please complete the attached consent form, tick yes or no in the appropriate box, and return to the school. If you have any questions regarding the project, please do not hesitate to contact me on the details at the top of this form.

Sincerely,
Isaac Martin

This research project has been approved by the Human Research Ethics Committee of the Faculty of Arts and Social Sciences. Any questions about the ethical conduct of this research may be sent to the Secretary of the Committee, email alpss-ethics@waikato.ac.nz, postal address, Division of Arts, Law, Psychology and Social Sciences, University of Waikato, Te Whare Wananga o Waikato, Private Bag 3105, Hamilton 3240.

School of Psychology

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Informed Consent Form – Parents/Guardians of Select Students

Research Project: The Effect of BodyfurnFlex Chairs and Environmental Factors on the Behaviour and Movement of Students.

I _____ have read and understood the Information Sheet regarding the above research project. Any questions that I have, relating to the research, have been answered to my satisfaction. I understand that I can withdraw consent at any time during the project. I understand that the student's identity will remain anonymous in the presentation of the research findings.

Please complete the following checklist. Tick [✓] to indicate your response.	**YES**	**NO**
I give consent for my child to participate in this project.		
I give consent for my child to be recorded on video camera.		

Student's name:

Date:

Signature (Parent/Guardian):

Appendix F: Other Students Information Sheet and Consent Form – Studies 1 and 2

School of Psychology

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Information Sheet – Other Students

Associate Professor Angelika Anderson
School of Psychology
The University of Waikato
Phone: 07 838 4466 ext 9209
Email: angelika.anderson@waikato.ac.nz

PhD Student Isaac Martin
Phone: 0277148020
Email: im47@students.waikato.ac.nz

Dear Student,
You are invited to be a part of a research project at your school. Isaac Martin is a student at the University of Waikato and is doing a study as part of his coursework under the supervision of Associate Professor Angelika Anderson. Please read the entire information sheet before deciding if you would like to take part in the project. If you have any questions about the project, you can ask Isaac, your teacher or ask a parent/caregiver to contact Isaac or Angelika.

What is the research about?

The research project will investigate if your regular classroom chairs or a new type of chair called BodyfurnFlex make it easier for you to do your schoolwork. BodyfurnFlex Chairs are a brand-new chair that is designed to increase comfort and make it easier for you to concentrate. Information about the previous version of Bodyfurn chairs can be found at https://www.furnware.co.nz/products/bodyfurn/bodyfurn-sled-chair.

We will also investigate if things like temperature and noise in the classroom make it more difficult for you to learn. I completed a similar project in 2020, which you can find using the following link: https://researchcommons.waikato.ac.nz/handle/10289/14338.

What will happen?

During the study, you will have periods where you sit in the BodyfurnFlex chair, and then at other times you will sit in the regular classroom chairs. This is so we can study how the different chair affect your behaviour and learning. Motion sensor cameras will be set up in the corner of the room to record your movement. Data will be collected during regular class time, several days a week. I will set up the equipment before class, and you will continue your regular class activities as normal. The Project will take place over School Terms 2 & 3 (20 school weeks) for approximately 5 months (April – September 2023).

What will happen when the study is finished?

I will write a report about the results of the study as part of my university work. None of the video footage will be released and will only be seen by me. No personal details like your name will ever appear in the results or anywhere else. No one will be able to identify you in from this study. I will send the school a summary of the results and they will give you a copy of the

results. If you want to know what happened in the study, you can ask me, your teacher or a parent/caregiver to contact me, and I will send you a summary of the results.

What if I don't want to be in the project?

Not taking part in the study will not affect your learning or experience in the classroom. Only certain sections of the classroom will be on camera, and only students who are participating in the project will be recorded. If you do not take part in the project, you will continue class as normal, and we will make sure you are not on camera. Participation in this project is always voluntary and you have the right to withdraw from the project at any time, even after signing a consent form. If at any time during the project you decide that you don't want to be in the study anymore, you can tell me, a teacher or a parent/caregiver, and you will be removed from the study and continue class as normal. You will have up to 3 weeks after the project finishes (end of term 3) to remove your data from the study.

What happens now?

If you would like to be a part of this project, please fill out the assent form and return it to your teacher or directly to me.

Sincerely,
Isaac Martin

This research project has been approved by the Human Research Ethics Committee of the Faculty of Arts and Social Sciences. Any questions about the ethical conduct of this research may be sent to the Secretary of the Committee, email alpss-ethics@waikato.ac.nz, postal address, Division of Arts, Law, Psychology and Social Sciences, University of Waikato, Te Whare Wananga o Waikato, Private Bag 3105, Hamilton 3240.

School of Psychology

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Passive Assent Form – Other Students

Research Project: The Effect of BodyfurnFlex Chairs and Environmental Factors on the Behaviour and Movement of Students.

I _____ have read and understand the attached Information Sheet describing the research project. Any questions that I had about the study have been answered. I understand that I can stop participating in the project at any time. I am happy for the researcher to use the data collected during the project for their research as described in the Information Sheet. I understand that my identity will be kept hidden from the results of the study, and that my name will never be mentioned in any report.

Please complete the following checklist. Tick [✓] to indicate your response.	**YES**	**NO**
I want to take part in this research project.		

Date:

Signature:

Appendix G: Parents of Other Students Information Sheet and Consent Form - Studies 1 and 2

School of Psychology

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Information Sheet – Parents/Guardians of Other Students

Associate Professor Angelika Anderson
School of Psychology
The University of Waikato
Phone: 07 838 4466 ext 9209
Email: angelika.anderson@waikato.ac.nz

PhD Student Isaac Martin
Phone: 0277148020
Email: im47@students.waikato.ac.nz

Dear Parents/Guardians,
Your child has been chosen to participate in a research project conducted by myself, Isaac Martin, under the supervision of Associate Professor Angelika Anderson from School of Psychology at the University of Waikato. This project is part of the requirement for the completion of my PhD in Behaviour Analysis at the University of Waikato. Please read this information sheet in full before deciding if you consent to your child participating in the project. If you have any questions about the project, please do not hesitate to contact myself or Angelika via the contact details above.

What is the research about?

The research project will focus on two aspects; the first will be to investigate how BodyfurnFlex Chairs affect the behaviour and learning outcomes of students in the classroom. BodyfurnFlex Chairs are a new ergonomic chair, designed to improve comfort and increase concentration. Information about the previous version of Bodyfurn chairs can be found at https://www.furnware.co.nz/products/bodyfurn/bodyfurn-sled-chair.

The second aspect of the project will explore how changes in certain environmental factors in the classroom, such as noise and air quality, affect the movement of students and alter the learning environment. This project will seek to build upon the findings of my master's research project that was conducted in 2020. My master's thesis is available in the University of Waikato research commons:
https://researchcommons.waikato.ac.nz/handle/10289/14338.

What will be Involved?

During the study, students will have periods where they sit in the BodyfurnFlex chair, and then at other times they will sit in the regular classroom chairs. This is so we can observe how the different chairs affect the student's behaviour, movement and learning. Data will be collected using motion sensor cameras (to record overall movement in the classroom), and small sensors that record noise levels and environmental variables. Equipment will be set up prior to class (e.g., before school or during break time) and in a way that does not interfere with learning. Cameras will be placed in the corners of the room and out of the way of students. Data collection will take place during regular class time (approximately one-hour sessions) several days a week. It is important to emphasise that data will be collected during regular classroom activities and will not interfere with the students' learning or education.

The Project will take place over School Terms 2 & 3 (20 school weeks) for approximately 5 months (April – September 2023).

What will happen with the Results?

The results of the study will be reported in my final PhD thesis and potentially academic journal articles. Results may also be used in product advertisement for BodyfurnFlex chairs. The school will be provided with a summary of the results and will also be notified whenever results are published (e.g., thesis or journal articles). The school will provide participants with a summary of the results and will notify participants of any new publications. You may also contact the researchers directly to enquire about any results/publications.

Confidentiality

Any details of students and teachers will be treated with a high level of confidentiality, and all data will be reported anonymously. No participants will be identifiable in the presentation of any results.

What if I don't want my child to take part in the study?

Not taking part in the study will in no way affect your child's learning or experience in the classroom. Only certain sections of the classroom will be on camera and only students who are participating in the project will be recorded. Students who do not take part in the project will continue class as normal, and we will make sure they are not on camera. Participation in this project is voluntary and all participants have the right to withdraw from the project at any time, even after signing a consent form. You will have up to three weeks after the conclusion of the project (end of term 3) to request to have your student's data removed from the study.

What happens now?

If you are happy for your child to be a part of this project, you do not need to do anything further. However, if you do not want your child to take part in this project, please complete the withholding consent form, tick yes or no in the appropriate box, and return it to the school. If you have any questions regarding the project, please do not hesitate to contact me on the details at the top of this form.

Sincerely,
Isaac Martin

This research project has been approved by the Human Research Ethics Committee of the Faculty of Arts and Social Sciences. Any questions about the ethical conduct of this research may be sent to the Secretary of the Committee, email alpss-ethics@waikato.ac.nz, postal address, Division of Arts, Law, Psychology and Social Sciences, University of Waikato, Te Whare Wananga o Waikato, Private Bag 3105, Hamilton 3240.

School of Psychology

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Withholding Consent Form – Parents/Guardians of Other Students

Research Project: The Effect of BodyfurnFlex Chairs and Environmental Factors on the Behaviour and Movement of Students.

I _____ have read and understood the Information Sheet regarding the above research project. Any questions that I have, relating to the research, have been answered to my satisfaction. I understand that I can withdraw consent at any time during the project. I understand that the student's identity will remain anonymous in the presentation of the research findings.

Please complete the following checklist. Tick [✓] to indicate your response.	**YES**	**NO**
I give consent for my child to participate in this project.		

Student's name:

Date:

Signature (Parent/Guardian):

Appendix H: Teacher Information Sheet and Consent Form – Study 3

School of Psychology

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Information Sheet – Teachers

Associate Professor Angelika Anderson
School of Psychology
The University of Waikato
Phone: 07 838 4466 ext 9209
Email: angelika.anderson@waikato.ac.nz

PhD Student Isaac Martin
Phone: 0277148020
Email: im47@students.waikato.ac.nz

To whom it may concern,
You are invited to participate in a research project conducted by Isaac Martin, under the supervision of Associate Professor Angelika Anderson from School of Psychology at the University of Waikato. This project is part of the requirement for the completion of my PhD in Behaviour Analysis at the University of Waikato. Please read this information sheet in full before deciding if you would like to participate in the project. If you have any questions about the project, please do not hesitate to contact me or Angelika via the contact details above.

What is the Project about?

The goal of this research project is to investigate if BodyfurnFlex chairs can affect the academic outcomes of students. BodyfurnFlex Chairs are a brand-new ergonomic chair designed to improve comfort and increase concentration. Information about the BodyfurnFlex chair can be found at https://www.furnware.com/en-nz/products/admin-office/bodyfurn-flex-sled-chair.

The goal of the project is to compare the test scores of students who learn a particular topic (e.g., Algebra) when seated in BodyfurnFlex chairs with students who learned the material when seated in their regular classroom chairs.

What will be involved?

Your classroom will be randomly assigned to either the regular chairs group (where your students will continue to use their regular classroom chairs) or the Bodyfurn chair group (where your students will be supplied with BodyfurnFlex chairs). Students will stay in the same chairs throughout the course of learning the topic and during the test taking.

This project will not involve any changes to your normal teaching procedure/curriculum. The study just involves controlling the chairs the students use and then collecting test results. This study will involve two separate topics, Algebra in Term 3 and Number in Term 4.

What will your role be in the Project?

It is important to note that your teaching is not being evaluated in this project. The role of the teachers is to conduct classroom activities as usual (i.e., teaching and testing the material) and ensuring that students remain in the chairs that they have been assigned throughout the

course of the topic. It is very important that your students stay in the chairs that they have been assigned to.

Sharing of Test Scores

All test scores provided to researchers need to be anonymous. The students' names should be removed from the list of test scores prior to sharing with researchers. Only students who have given their signed permission should have their test results included in the final list of results that are shared with the researchers.

No test results should be shared with the researchers any earlier than 3 weeks after the administration of the test. This is to give students adequate time to withdraw their results from the research project.

Results of the Study

The results of the study will be reported in my final PhD thesis and potentially in academic journal articles. Results may also be used in product advertisement for BodyfurnFlex chairs. The school will be provided with a summary of the results and will also be notified whenever results are published (e.g., thesis or journal articles). The school will forward the summary of results to participants and notify you of any new publications. You may also contact the researchers directly to enquire about any results/publications.

Confidentiality and Anonymity

All data that you share with the researchers will be treated with a high level of confidentiality and will be reported anonymously. Your name will not be included in the publishing of any results. Since there will be multiple classrooms taking part in this project, your classroom will not be able to be identified by anyone else in the presentation of the results.

Right to withdraw

Participation in this project is voluntary and all participants have the right to withdraw from the project at any time, even after signing a consent form.

What happens now?

If you would like to be a part of this project, please complete the attached consent form. If you have any questions regarding the project, please do not hesitate to contact me at the details at the top of this form.

Sincerely,
Isaac Martin

This research project has been approved by the Human Research Ethics Committee of the Faculty of Arts and Social Sciences. Any questions about the ethical conduct of this research may be sent to the Secretary of the Committee, email alpss-ethics@waikato.ac.nz, postal address, Division of Arts, Law, Psychology and Social Sciences, University of Waikato, Te Whare Wananga o Waikato, Private Bag 3105, Hamilton 3240.

School of Psychology

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Consent Form – Teachers

Research Project: The Effect of BodyfurnFlex Chairs on the Academic Performance of Students.

I _____ have received a copy of the Information Sheet describing the research project and have been given sufficient time to read it. Any questions that I have, relating to the research, have been answered to my satisfaction. I understand that I can ask further questions about the research at any time during my participation, and that I can withdraw my participation at any time. I understand that my identity will remain confidential in the presentation of the research findings.

Date:

Signature:

Appendix I: Student Information Sheet and Assent Form – Study 3

School of Psychology

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Information Sheet – Students

Associate Professor Angelika Anderson
School of Psychology
The University of Waikato
Phone: 07 838 4466 ext 9209
Email: angelika.anderson@waikato.ac.nz

PhD Student Isaac Martin
Phone: 0277148020
Email: im47@students.waikato.ac.nz

Dear Student,
You have been chosen to participate in a research project conducted by me, Isaac Martin, under the supervision of Associate Professor Angelika Anderson from the School of Psychology at the University of Waikato. This project is part of my coursework at the University of Waikato. Please read the entire information sheet before deciding if you would like to take part in the project. If you have any questions about the project, you can ask me, your teacher or ask a parent/caregiver to contact Isaac or Angelika.

What is the research about?

The goal of this research project is to investigate whether BodyfurnFlex chairs can affect your learning. BodyfurnFlex Chairs are a brand-new ergonomic chair designed to improve comfort and increase concentration. Information about the BodyfurnFlex chair can be found at https://www.furnware.com/en-nz/products/admin-office/bodyfurn-flex-sled-chair.

The study will involve comparing the test scores of students who learn a particular topic (e.g., algebra) when seated in Bodyfurn chairs with students who learned the material when seated in regular classroom chairs.

What will happen?

Your classroom will be randomly assigned to either the regular chairs group (where you and your classmates will continue to use their regular classroom chairs) or the bodyfurn chair group (where you will be supplied with BodyfurnFlex chairs). You will stay in the same chairs throughout the course of learning a topic and during the test taking. If you give your permission, your test results will be anonymously shared with the researchers (i.e., only your test score will be shared, your name will not be included). This study will involve two separate topics, Algebra in term 3 and Number in term 4.

What will happen when the study is finished?

I will write a report about the results of the study as part of my university work. No personal details like your name will ever appear in the results or anywhere else. No one will be able to identify you from this study. I will send the school a summary of the results and they will give

you a copy of the results. If you want to know what happened in the study you can ask me, your teacher or a parent/caregiver to contact me, and I will send you a summary of the results.

What if I don't want to take part in the project?

Not taking part in the study will not affect your learning or experience in the classroom. Only students who give their signed permission will have their test results included in the study. If you do not want to take part in the project, you will continue class as normal, and your test results will not be shared with the researchers.

Participation in this project is always voluntary and you have the right to withdraw from the project at any time, even after signing a consent form. If at any time during the project, you decide that you don't want to be in the study anymore you can tell your teacher and your results will be removed from the study. You will have up to 3 weeks after the completion of the test to request to not have your results included in the study.

What happens now?

If you would like to be a part of this project, please fill out the assent form and return it to your teacher.

Sincerely,
Isaac Martin

This research project has been approved by the Human Research Ethics Committee of the Faculty of Arts and Social Sciences. Any questions about the ethical conduct of this research may be sent to the Secretary of the Committee, email alpss-ethics@waikato.ac.nz, postal address, Division of Arts, Law, Psychology and Social Sciences, University of Waikato, Te Whare Wananga o Waikato, Private Bag 3105, Hamilton 3240.

School of Psychology

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Passive Assent Form – Students

Research Project: The Effect of BodyfurnFlex Chairs on the Academic Performance of Students.

I _____ have read and understand the attached Information Sheet describing the research project. I understand that I can stop participating in the project at any time. I am happy for the researcher to use the data collected during the project for their research as described in the information sheet. I understand that my identity will be kept hidden from the results of the study, and that my name will never be mentioned in any report.

Please complete the following checklist. Tick [✓] to indicate your response.	**YES**	**NO**
I agree to have my test results included in the research project.		

Date:

Signature:

Appendix J: Parent Information Sheets and Consent Form – Study 3

School of Psychology

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Information Sheet – Parents/Guardians

Associate Professor Angelika Anderson
School of Psychology
The University of Waikato
Phone: 07 838 4466 ext 9209
Email: angelika.anderson@waikato.ac.nz

PhD Student Isaac Martin
Phone: 0277148020
Email: im47@students.waikato.ac.nz

Dear Parents/Guardians,
Your child has been chosen to participate in a research project conducted by me, Isaac Martin, under the supervision of Associate Professor Angelika Anderson from the School of Psychology at the University of Waikato. This project is part of the requirement for the completion of my PhD in Behaviour Analysis. Please read this information sheet in full before deciding if you consent to your child participating in the project. If you have any questions about the project, please do not hesitate to contact me or Angelika via the contact details above.

What is the research about?

The goal of this research project is to investigate if BodyfurnFlex chairs can affect the learning of students. BodyfurnFlex Chairs are a brand-new ergonomic chair designed to improve comfort and increase concentration. Information about the BodyfurnFlex chairs can be found at https://www.furnware.com/en-nz/products/admin-office/bodyfurn-flex-sled-chair/
The study will involve comparing the test scores of students who learn a particular topic (e.g., algebra) when seated in Bodyfurn chairs with students who learned the material when seated in regular classroom chairs.

What will be Involved?

Your child's classroom will be randomly assigned to either the regular chairs group (where the students will continue to use their regular classroom chairs) or the Bodyfurn chair group (where the students will be supplied with BodyfurnFlex chairs). They will stay in the same chairs throughout the course of learning a topic and during the test taking. For those who give permission, their test results will be anonymously shared with researchers. This study will involve two separate topics, Algebra in term 3 and Number in term 4.

It is important to note that this project will not involve any changes to the normal teaching procedure/curriculum, and the students' learning will not be affected. We will just be controlling the chairs the students use and then collecting test results.

Confidentiality and Anonymity

All test scores will be collected and reported anonymously. The teacher will remove student names from the list of test scores prior to sharing with researchers. No participants will be identifiable in the presentation of any results.

What will happen with the Results?

The results of the study will be reported in my final PhD thesis and potentially academic journal articles. Results may also be used in product advertisement for BodyfurnFlex chairs. The school will be provided with a summary of the results and will also be notified whenever results are published (e.g., thesis or journal articles). The school will provide participants with the summary of the results and will notify participants of any new publications. You may also contact the researchers directly to inquire about any results/publications.

What if I don't want my child to take part in the study?

Not taking part in the study will in no way affect your child's learning or experience in the classroom. Only those who give permission will have their test results included in the research. Students who do not take part in the project will continue class as normal, and their test results will not be shared with the researchers.

Participation in this project is voluntary and all participants have the right to withdraw from the project at any time, even after signing a consent form. You will have up to three weeks after the conclusion of the administration of the final test to request to have your student's results not included in the study.

What happens now?

If you are happy for your child to be a part of this project, you do not need to do anything further. However, if you do not consent to your child taking part in this project, please complete the withholding consent form, tick yes or no in the appropriate box, and return it to the school. If you have any questions regarding the project, please do not hesitate to contact me using the details at the top of this form.

Sincerely,
Isaac Martin

This research project has been approved by the Human Research Ethics Committee of the Faculty of Arts and Social Sciences. Any questions about the ethical conduct of this research may be sent to the Secretary of the Committee, email alpss-ethics@waikato.ac.nz, postal address, Division of Arts, Law, Psychology and Social Sciences, University of Waikato, Te Whare Wananga o Waikato, Private Bag 3105, Hamilton 3240.

School of Psychology

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Withholding Consent Form – Parents/Guardians

Research Project: The Effect of BodyfurnFlex Chairs on the Academic Performance of Students.

I _____ have read and understood the information sheet regarding the research project. I understand that I can withdraw consent at any time during the project. I understand that the student's identity will remain anonymous in the presentation of the research findings.

Please complete the following checklist. Tick [✓] to indicate your response.	**YES**	**NO**
I give consent for my child's test results to be included in the research project.		

Student's name:

Date:

Signature (Parent/Guardian):

Appendix K: Teacher Information Sheet and Consent Form – Focus Groups

School of Psychology

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Information Sheet (Focus Group) – Teachers

Associate Professor Angelika Anderson
School of Psychology
The University of Waikato
Phone: 07 838 4466 ext 9209
Email: angelika.anderson@waikato.ac.nz

PhD Student Isaac Martin
Phone: 0277148020
Email: im47@students.waikato.ac.nz

To whom it may concern,

Thank you for your participation in the Research Project**:** The Effect of BodyfurnFlex Chairs on the Academic Performance of Students. You are invited to participate in a follow-up focus group discussion with your fellow teachers to provide feedback about the chairs and project. Please read this information sheet in full before deciding if you would like to participate in the focus group. If you have any questions, please do not hesitate to contact me or Angelika via the contact details above.

What will be involved?

The student researcher, Isaac, will lead a short informal discussion (approx. 5-10 minutes) with your fellow teachers about the chairs and the research project. We will discuss your opinions on the chairs and if you felt that they affected the behaviour or learning of the students. You will also be given the opportunity to give any other feedback about the chairs or the research project. An audio recording of the group discussion will be taken so that a full transcription (written version of the discussion) can be made and to make sure that nothing was missed. The audio recording of the discussion will be transcribed by the student researcher with the assistance of the automatic transcription software Otter.ai.

Results

The feedback you provide will be included in my final PhD thesis and potentially academic journal articles. Results may also be used in product advertisement for BodyfurnFlex chairs. Schools will be provided with a summary of the results and will also be notified whenever results are published (e.g., thesis or journal articles). The school will forward the summary of results to participants and notify you of any new publications. You may also contact the researchers directly to enquire about any results/publications.

Confidentiality and Anonymity

All feedback that you share with the researchers will be treated with a high level of confidentiality and all feedback you give will be reported anonymously. The audio recording will only be used for the purpose of transcribing the conversation and will not be released or heard by anyone else outside of the researcher. No personal details like your name will be presented anywhere in the results.

Right to withdraw

Participation in the discussion is voluntary and you have the right to withdraw from the discussion at any time, even after signing a consent form. You will have up to 3 weeks after the focus group discussion to request to have your feedback removed from the results. If you wish to have your feedback removed, please let me know via the contact details provided.

What happens now?

If you are happy to take part in the focus group discussion, please complete the consent form and return it to me. If you have any questions regarding the project, please do not hesitate to contact me at the details at the top of this form.

Sincerely,
Isaac Martin

This research project has been approved by the Human Research Ethics Committee of the Faculty of Arts and Social Sciences. Any questions about the ethical conduct of this research may be sent to the Secretary of the Committee, email alpss-ethics@waikato.ac.nz, postal address, Division of Arts, Law, Psychology and Social Sciences, University of Waikato, Te Whare Wananga o Waikato, Private Bag 3105, Hamilton 3240.

School of Psychology

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Consent Form – Teachers (Focus Group)

Research Project: The Effect of BodyfurnFlex Chairs on the Academic Performance of Students.

I _____ have read and understand the attached Information Sheet describing the focus group. Any questions that I had, relating to the focus group, have been answered. I understand that I can stop participating in the discussion at any time. I am happy for the researcher to use my feedback for their research as described in the Information Sheet. I understand that my identity will be kept hidden from the results of the study, and that my name will never be mentioned in any report.

Please complete the following checklist. Tick [✓] to indicate your response.	**YES**	**NO**
I agree to take part in the focus group to discuss my opinions on the chairs.		

Date:

Signature:

Appendix L: Student Information Sheet and Assent Form – Focus Groups

School of Psychology

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Information Sheet (Focus Group) – Students

Associate Professor Angelika Anderson
School of Psychology
The University of Waikato
Phone: 07 838 4466 ext 9209
Email: angelika.anderson@waikato.ac.nz

PhD Student Isaac Martin
Phone: 0277148020
Email: im47@students.waikato.ac.nz

To whom it may concern,

Thank you for your participation in the Research Project**:** The Effect of BodyfurnFlex Chairs on the Academic Performance of Students. You are invited to participate in a follow-up focus group discussion with some of your fellow classmates to provide feedback about the chairs and the project. Please read this information sheet in full before deciding if you would like to participate in the focus group. If you have any questions about the project, you can ask Isaac, your teacher or ask a parent/caregiver to contact Isaac or Angelika.

What will be involved?

The student researcher, Isaac, will lead a short informal discussion (approx. 5-10 minutes) with 4-5 of your fellow classmates about the chairs and the research project. We will discuss your opinions on the chairs and if you felt that they affected the learning. You will also be given the opportunity to give any other feedback about the chairs or the research project. An audio recording of the group discussion will be taken so that a full transcription (written version of the discussion) can be made. This is to ensure that none of the feedback that you give will be missed.

What happens after the discussion?

The feedback you provide will be included in my final PhD thesis and potentially academic journal articles. Results may also be used in product advertisement for BodyfurnFlex chairs. Schools will be provided with a summary of the results and will also be notified whenever results are published (e.g., thesis or journal articles). The school will forward the summary of results to participants and notify you of any new publications. You may also contact the researchers directly to enquire about any results/publications. The audio recording of the discussion will be transcribed by the student researcher with the assistance of the automatic transcription software Otter.ai.

Confidentiality and Anonymity

All feedback that you share with the researchers will be treated with a high level of confidentiality and all feedback you give will be reported anonymously. The audio recording will only be used for the purpose of transcribing the conversation and will not be released or heard by anyone else outside of the researcher. No personal details like your name will be presented anywhere in the results.

Right to withdraw

Participation in the discussion is voluntary and you have the right to withdraw from the discussion at any time, even after signing the assent form. If at any point during the discussion you decide you do not want to continue, please let me know and you are free to leave at any time. If you decide that you don't want what you talked about in the group discussion to be included in the study, you can tell me or your teacher who will let me know, and your feedback will be removed from the study. You will have up to 3 weeks after the after the group discussion test to request to not have your feedback included the study.

What happens now?

If you are happy to take part in the focus group discussion, please complete the assent form and return it to your teacher.

Sincerely,
Isaac Martin

This research project has been approved by the Human Research Ethics Committee of the Faculty of Arts and Social Sciences. Any questions about the ethical conduct of this research may be sent to the Secretary of the Committee, email alpss-ethics@waikato.ac.nz, postal address, Division of Arts, Law, Psychology and Social Sciences, University of Waikato, Te Whare Wananga o Waikato, Private Bag 3105, Hamilton 3240.

School of Psychology

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Assent Form – Students (Focus Group)

Research Project: The Effect of BodyfurnFlex Chairs on the Academic Performance of Students.

I _____ have read and understand the attached Information Sheet describing the focus group. Any questions that I had about the study have been answered. I understand that I can stop participating in the discussion at any time. I am happy for the researcher to use my feedback for their research as described in the Information Sheet. I understand that my identity will be kept hidden from the results of the study, and that my name will never be mentioned in any report.

Please complete the following checklist. Tick [✓] to indicate your response.	**YES**	**NO**
I agree to take part in the focus group to discuss my opinions on the chairs.		

Date:

Signature:

Appendix M: Parent Information Sheet and Consent Form - Focus Groups

School of Psychology

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Information Sheet (Focus Group) – Parents/Guardians

Associate Professor Angelika Anderson
School of Psychology
The University of Waikato
Phone: 07 838 4466 ext 9209
Email: angelika.anderson@waikato.ac.nz

PhD Student Isaac Martin
Phone: 0277148020
Email: im47@students.waikato.ac.nz

To whom it may concern,

Thank you for allowing your child to participate in the Research Project**:** The Effect of BodyfurnFlex Chairs on the Academic Performance of Students. Your child has been invited to participate in a follow-up focus group discussion with some of their fellow classmates to provide feedback about the chairs and project. Please read this information sheet in full before deciding if you consent to your child participating in the focus group. If you have any questions, please do not hesitate to contact me or Angelika via the contact details above.

What will be involved?

The student researcher, Isaac, will lead a short informal group discussion (approx. 5-10 minutes) with your child and 4-5 of their classmates about the chairs and the research project. We will discuss their opinions on the chairs and if they felt that they affected the learning. They will also be given the opportunity to give any other feedback about the chairs or the research project. An audio recording of the group discussion will be taken so that a full transcription (written version of the discussion) can be made. This is to ensure that none of the feedback will be missed. The audio recording of the discussion will be transcribed by the student researcher with the assistance of the automatic transcription software Otter.ai.

What happens after the discussion?

The feedback from the students will be included in the results of the study as part of my university work. All feedback will be reported anonymously and no personal details like their name will appear in the results. No one will be able to identify them from this study. The audio recordings will only be used for the purposes of transcribing the discussion and will not be released or heard by anyone except the researcher. The school will be provided with a summary of the results and will also be notified whenever results are published (e.g., thesis or journal articles). The school will provide participants with a summary of the results and will

notify participants of any new publications. You may also contact the researchers directly to enquire about any results/publications.

Right to withdraw

Participation in the discussion is voluntary and you and the student has the right to withdraw from the discussion at any time, and you have the right to withdraw consent at any time, even after signing a consent form. If you decide that you do not want your child's feedback included in the study, please let their teacher or me know, via the contact details provided, and their feedback will be removed from the results. You will have up to 3 weeks after the after the group discussion test to request to not have your feedback included the study

What happens now?

If you are happy for your child to be a part of the focus group discussion, please complete the consent form and return it to the school. If you have any questions regarding the project, please do not hesitate to contact me at the details at the top of this form.

Sincerely,
Isaac Martin

This research project has been approved by the Human Research Ethics Committee of the Faculty of Arts and Social Sciences. Any questions about the ethical conduct of this research may be sent to the Secretary of the Committee, email alpss-ethics@waikato.ac.nz, postal address, Division of Arts, Law, Psychology and Social Sciences, University of Waikato, Te Whare Wananga o Waikato, Private Bag 3105, Hamilton 3240.

School of Psychology

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Consent Form – Parents/Guardians (Focus Group)

Research Project: The Effect of BodyfurnFlex Chairs on the Academic Performance of Students.

I _____ have read and understood the Information Sheet regarding the focus group. Any questions that I have, relating to the research, have been answered to my satisfaction. I understand that I can withdraw consent at any time. I understand that my child's identity will remain anonymous in the presentation of the research.

Please complete the following checklist. Tick [✓] to indicate your response.	**YES**	**NO**
I give consent for my child to take part in a focus group discussion with the researcher about their opinions on the chairs.		

Student's name:

Date:

Signature (Parent/Guardian):

Appendix N: On-Task Behaviour Data Coding Sheet

On-Task Behaviour Data Coding Sheet

Group: **Session**: **Video Observation Time**:

Momentary Time Sampling of On-Task Behaviour

Interval time: 20 seconds
Behaviour: On-task Behaviour

✓= On-task behaviour present
✗ = On-task behaviour <u>not</u> present (i.e., off-task behaviour)
A= Absent – the student could not be seen (e.g., off-camera or completely obscured).

		Student									
Interval	**End Time**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1											
2											
3											
4											
5											
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74											
75											
Total Behaviour											
Total Intervals											

Appendix O: Disruptive Behaviour Data Coding Sheet

Disruptive Behaviour Data Coding Sheet

Group: **Session**: **Video Observation Time**:

Event sampling of Disruptive Behaviour

Interval time: 20 seconds
Behaviour: Disruptive Behaviour

✓= Indicates one instance of disruptive behaviour
A= Absent – student could not be seen (e.g., off-camera) for the entire interval.

		Student									
Interval	**Start Time**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1											
2											
3											
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75											
Total Behaviour											
Total Intervals											

Appendix P: Out-of-Seat Behaviour Data Coding Sheet

Out-of-Seat Behaviour Data Coding Sheet

Group: **Session**: **Video Observation Time**:

Partial Interval Recording of Out-of-Seat Behaviour

Interval time: 20 seconds
Behaviour: Out-Of-Seat Behaviour

✓= The student did exhibit Out-of-Seat Behaviour at any point during the interval
A= Absent – the student was out-of-seat for a task-related reason for the <u>entire</u> interval

		Student									
Interval	**Start Time**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1											
2											
3											
4											
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Total Behaviour											
Total Intervals											

Appendix Q: Chair Tipping Data Coding Sheet

Chair Tipping Data Coding Sheet

Group: **Session**: **Video Observation Time**:

Partial Interval Recording of Chair Tipping

Interval time: 20 seconds
Behaviour: Chair Tipping

✓= The student exhibited Chair Tipping at <u>any point</u> during the interval
A= Absent – The student was <u>not</u> seated for the <u>entire</u> interval.

		Student									
Interval	**Start Time**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1											
2											
3											
4											
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Total Behaviour											
Total Intervals											

Appendix R: Behaviour Operational Definitions

OPERATIONAL DEFINITIONS

On-Task Behaviour

On-task behaviour is defined as behaviour where students are actively engaged in learning activities. For a student to be marked as on-task they need to be attending to or engaged in the task either visually (e.g., looking at the teacher, speaker, or task material), verbally (e.g., asking/answering questions or discussing the task) or physically (e.g., writing, gluing, cutting). Additionally, following teacher instructions (e.g., "when you finish your work, sit and wait quietly" or "can you go and close that window, please") should also be marked as on-task behaviour.

Disruptive Behaviour

Disruptive behaviour is defined as any behaviour that causes another student to stop their on-task behaviour (i.e., become off-task) or causes the teacher to stop teaching. It is the function (i.e., disruption) of the behaviour and not the behaviour itself that is being recorded. There are many behaviours that could cause disruption to other students but if it does not actually cause another student to become off-task then it should not be recorded as a disruptive behaviour. Task-related behaviours such as asking questions or engaging in task-related discussion should not be marked as a disruptive behaviour.

Out-of-Seat Behaviour

Out-of-seat behaviour is defined as any time a student loses contact with the seat of their chair without permission from the teacher or it is not for a task related reason (e.g., standing up to fetch a pair of scissors).

Chair Tipping

Chair tipping is defined as any time a student was seated and part of any chair leg or base lost contact with the floor.

Appendix S: Interobserver Agreement Instructions

INTEROBSERVER AGREEMENT INSTRUCTIONS

On-Task Behaviour

On-task behaviour is recorded using momentary time sampling at 20 second intervals. Momentary time sampling involves observing whether a behaviour occurs or does not occur at a specified moment in time. The observer will mark each participant as either on-task or off-task at the end of each 20 second interval. If a student is not present (i.e., not on camera) at the 20 second mark of an interval (e.g., they went to the bathroom) then they should be marked as absent.

Disruptive Behaviour

Disruptive behaviour is measured using event recording. Event recording involves tallying each occurrence of disruptive behaviour over the observation period. It does not matter if a disruptive behaviour disrupts one student or multiple students, it should still be tallied as just one occurrence of disruptive behaviour. Disruptive behaviours should be tallied in the column of the student who exhibited that behaviour and in the interval in which it occurred. A student should be marked as absent only if they are off-camera for the entire interval (i.e., all 20 seconds).

Out-of-Seat Behaviour

Out-of-seat behaviour is measured using partial interval recording. Partial interval recording involves recording if a behaviour occurs or does not occur during the interval. If a participant exhibits out-of-seat behaviour at ANY point during the 20-second interval then the behaviour should be marked as present in the column of the student who displayed the behaviour. If a student leaves their seat for a task-related reason (e.g., to fetch a pair of scissors), then they should be marked as absent, but only if they are out of the seat for the entire interval (i.e., all 20 seconds).

Chair Tipping

Chair tipping is also measured using partial interval recording. The same procedure will be used as for out-of-seat behaviour. A student should be marked as absent if they are not seated for the entire interval (it does not matter if they are on or off-camera).

Appendix T: Co-Authorship Form Study 1

THE UNIVERSITY OF WAIKATO
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This form is to accompany the submission of any PhD that contains research reported in published or unpublished co-authored work. **Please include one copy of this form for each co-authored work.** Completed forms should be included in your appendices for all the copies of your thesis submitted for examination and library deposit (including digital deposit).

Please indicate the chapter/section/pages of this thesis that are extracted from a co-authored work and give the title and publication details or details of submission of the co-authored work. Chapter 4: Study 1 The Effect of BodyfurnFlex Chairs on the Movement and Behaviour of Students (Manuscript submitted for Publication)	
Nature of contribution by PhD candidate	Developed study and research methods in collaboration with co-authors, conducted data collection/ analysis, and wrote manuscript with advice/feedback from co-authors.
Extent of contribution by PhD candidate (%)	70%

CO-AUTHORS

Name	Nature of Contribution
Angelika Anderson	Assistance in developing research design/methods; advice on data analysis, reviewing and editing of drafts.
Nicola Starkey	Assistance in developing research design/methods; advice on data analysis; reviewing and editing of drafts.

Certification by Co-Authors

The undersigned hereby certify that:

- the above statement correctly reflects the nature and extent of the PhD candidate's contribution to this work, and the nature of the contribution of each of the co-authors; and
- that the candidate wrote all or the majority of the text.

Name	Signature	Date
Angelika Anderson	Angelika Anderson	27.08.2025
Nicola Starkey	Nicola Starkey	27/08/25

Appendix U: Co-Authorship Form Study 2

THE UNIVERSITY OF WAIKATO
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Please indicate the chapter/section/pages of this thesis that are extracted from a co-authored work and give the title and publication details or details of submission of the co-authored work. Chapter 5: Study 2 Active Sitting as an Intervention: The Effect of Movement on Student Behaviour	
Nature of contribution by PhD candidate	Developed study and research methods in collaboration with co-authors, conducted data collection/ analysis, and wrote manuscript with advice/feedback from co-authors.
Extent of contribution by PhD candidate (%)	80%

CO-AUTHORS

Name	Nature of Contribution
Angelika Anderson	Assistance in developing research design/methods; advice on data analysis, reviewing and editing of drafts.
Nicola Starkey	Assistance in developing research design/methods; advice on data analysis; reviewing and editing of drafts.

Certification by Co-Authors

The undersigned hereby certify that:

- the above statement correctly reflects the nature and extent of the PhD candidate's contribution to this work, and the nature of the contribution of each of the co-authors; and
- that the candidate wrote all or the majority of the text.

Name	Signature	Date
Angelika Anderson	Angelika Anderson	27.08.2025
Nicola Starkey	Nicola Starkey	27/08/25

Appendix V: Co-Authorship Form Study 3

THE UNIVERSITY OF WAIKATO
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Please indicate the chapter/section/pages of this thesis that are extracted from a co-authored work and give the title and publication details or details of submission of the co-authored work.
Chapter 6: Study 3 The Effect of Dynamic Chairs on the Perceptions and Academic Achievement of Students (Manuscript submitted for Publication)

Nature of contribution by PhD candidate	Developed study and research methods in collaboration with co-authors, conducted data collection/ analysis, and wrote manuscript with advice/feedback from co-authors.
Extent of contribution by PhD candidate (%)	80%

CO-AUTHORS

Name	Nature of Contribution
Angelika Anderson	Assistance in developing research design/methods; advice on data analysis, reviewing and editing of drafts.
Nicola Starkey	Assistance in developing research design/methods; advice on data analysis; reviewing and editing of drafts.

Certification by Co-Authors

The undersigned hereby certify that:

- the above statement correctly reflects the nature and extent of the PhD candidate's contribution to this work, and the nature of the contribution of each of the co-authors; and
- that the candidate wrote all or the majority of the text.

Name	Signature	Date
Angelika Anderson	Angelika Anderson	27.08.2025
Nicola Starkey	Nicola Starkey	27/08/25