Human Interaction and Emerging Technologies (IHIET-AI), Vol. 201, 2026, 462–472
https://doi.org/10.54941/ahfe1007200

Students as Partners in Addressing the Needs of the School Community: A Case Study From Post-Pandemic Physical Education and Sports Science in Singapore

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ABSTRACT

This paper adopts an auto-ethnographic stance to describe the processes of conceptualization, design and iteration of a project-in-progress, in which a team of high school students in Singapore applied themselves to the development of a mobile application in response to expressions of need from Physical Education and Sports Science teachers. The application in development has teacher-administrator and student modes, and is designed to assist teachers during the preparation for – and conduct of – an annual mandatory physical fitness test for students, namely running a distance of 2.4-kilometres. As Singapore is a city-state with a territorial area of only 735 square kilometres and a population of six million, the very high population density of 7800 persons per square kilometre means that the land area of each school campus across the island is necessarily limited. Schools are built as multistorey structures and few school campuses have the luxury of their own running track. Further, Singapore's position just one degree north of the equator means that annual precipitation is high (2100 millimetres per year) and relatively uniform across each month. Taken together, these factors mean that students practising for the 2.4-kilometre run are not able to run a geometrically symmetric route, and are sometimes out of sight from teachers within or around buildings and other sheltered spaces. Traditionally, this has meant that there is margin for error in the estimation of distance run by each student. These constraints have been brought in to sharper contrast in the years following the COVID-19 pandemic because of a general renewed interest amongst the education fraternity of the potential role outdoor physical activity may play in physical and mental well-being. In April 2024, teachers from a secondary school approached the authorial team to discuss the preceding problem and to understand the affordances and disaffordances of potential mediatory approaches. While still a work-in-progress, the paper documents the process of consultation, conceptualization, design, development and iteration primarily from the students' perspective, with a view to exploring the extent to which the student bodies of other schools might potentially be engaged as partners in developing solutions to problems faced by schools in general.

Keywords: Auto-ethnography, Educational technology, Mobile application development, Participatory models in education, Sport/science teacher education in Singapore, Teacher-student partnership

Received October 2, 2025; Revised November 28, 2025; Accepted December 4, 2025; Available online April 1, 2026

INTRODUCTION

Singapore's education system is meticulously structured and is often hailed as one of the top-performing systems globally. It aims to develop students holistically, ensuring they excel not only in academics but also in physical, emotional, and social aspects (Hogan Honorary Professor, 2024). Within this framework, Physical Education is a vital component, emphasizing the importance of physical fitness alongside intellectual growth. Physical education is integral to the curriculum and aims to instil lifelong fitness habits, encourage teamwork and promote mental well-being. As Singapore emerged into a post-pandemic environment, there has been renewed interest amongst the education fraternity of the potential role outdoor physical activity may play in physical and mental well-being. This paper describes an initiative which arose from this context, exploring a project where high school students in Singapore engaged collaboratively in developing a technology-driven solution for a practical issue identified by educators. The focus is a mobile application designed to support Physical Education and Sports Science teachers in administering the annual mandatory 2.4-kilometre run, an event integral to the student fitness assessment in Singapore. The mobile application aims to have features such as indoors route tracking, a unified student management system and individualized tracking of student status. The focus is a mobile application designed to support Physical Education and Sports Science teachers in administering the annual mandatory 2.4-kilometre run, an event integral to the student fitness assessment in Singapore. The mobile application aims to have features such as indoor route tracking, a unified student management system, and individualized tracking of student status. This project exemplifies the transformative potential of integrating student-led innovation into the educational landscape. It underscores the importance of fostering environments where students are not only recipients of knowledge but also active contributors to their educational journey. The impetus for this project stems from the unique challenges presented by Singapore's urban landscape. As a densely populated city-state with limited land area (Hirschmann, 2024a), schools often lack facilities like running tracks, forcing students to train in unconventional environments. These settings bring challenges such as estimating distances accurately and ensuring student safety, particularly when students are out of sight due to multilevel school structures or adverse weather conditions (Hirschmann, 2024b). Recognizing the need for a reliable solution, teachers from a secondary school reached out in April 2024 to solicit the expertise of the authors and their team of motivated students. The result has been a robust, collaborative effort that focused on creating a mobile app featuring both teacher-administrator and student modes. This digital tool aims to fortify the preparation and execution of the 2.4-kilometre run, providing teachers with accurate, real-time data to manage and assess student performance. Adopting an auto-ethnographic approach, this paper offers an insightful glimpse into the student led innovation journey. The narrative chronicles the phases of consultation, conceptualization, design, development and iterative refinement from the students' viewpoint. It also reflects on the broader

implications of engaging students as partners in tackling prevailing school challenges, setting the stage for similar collaborative models in education (Rapanta et al., 2021). By documenting this project, the paper seeks to inspire and facilitate dialogue on the potential roles students can play in enhancing educational practices and infrastructure. It underscores the value of student involvement in devising solutions that meet community needs, advocating for a shift towards more participatory models within the educational landscape (Marmolejo & Groccia, 2022). Through this case study, the paper illustrates how empowering students to contribute creatively and strategically can yield significant benefits for both learners and educators, particularly in the post-pandemic context, where flexibility, resilience, and innovative approaches to learning have become crucial to navigating the evolving educational landscape (Hews et al., 2022).

CONCEPTUALISATION AND DESIGN

The process of conceptualization began with an initial consultation with Physical Education and Sports Science teachers who had expressed a need for improved management of the 2.4-kilometre run. These discussions, conducted in April 2024, aimed to gain insights into the specific challenges teachers faced, gather their expectations for a potential solution and understand the limitations of existing methods. The teachers highlighted the issues of inaccurate distance estimation, student safety and logistical constraints imposed by existing facilities, factors which formed the basis for the conceptual exploration. The primary objective of the chosen solution was to create a mobile application that accurately tracks the 2.4-kilometre run while ensuring student safety and adherence to distance requirements. Other objectives include: enhancing the efficiency of the run's organization and enabling teachers to monitor and record student performance easily. The application aims to reduce errors associated with traditional methods and provide a reliable tool for both teachers and students. During the idealization process, the students proposed a two-application system – a client application for students to track the run and user telemetry, combined with an admin application for teachers to administer the run and ensure student safety throughout the process. The client software must be able to track the client's current location using GPS when outdoors, and it must calculate telemetry data such as pace and timing from raw sensor data. The data is to be transmitted in real-time speeds to the server to ensure student safety. However, there are some scenarios where students would need to run indoors, causing a potential loss in signal transmission. Furthermore, GPS transmission is severely limited indoors, with a measured accuracy of 60 meters (Peterson et al., 1997). Hence, the client software must have a feature to accurately determine distance travelled by the user indoors using a dead-reckoning algorithm. In this context, we used an extended Kalman Filter with Pedestrian Dead Reckoning. The administrator software was used to manage the clients, which are the students taking part in the NAPFA assessment. The administrator software shall contain features such as live monitoring of

student status, which includes speed, route, connectivity. The administrator software should also be able to manage student details and to have a "bird's eye view" on analytics within a class that allows the teacher to be able to see passing and failing rates, improvement and so on. Finally, the administrator software should be able to view historical data retrieved from the cloud and export the data in software-friendly formats such as excel.

DEVELOPMENT AND ITERATION

The development of the mobile application followed an iterative design process, aimed at refining the technology through continuous feedback and incremental improvements. This approach not only ensured that the solution effectively addressed the needs of teachers and students but also facilitated active collaboration with educational stakeholders throughout its development. The initial phase of the design process focused on creating a basic prototype of the mobile application, integrating core functionalities, such as GPS tracking and the dual-mode interface, for both teachers and students. This prototype served as a foundational model for subsequent iterations, allowing the development team to test basic functionalities and gather preliminary feedback. Upon completion of the initial prototype, a series of small-scale testing sessions were conducted in collaboration with classmates. These sessions involved a select group of students as assigned the role of "teachers", while the remaining students took the role of "students". During the sessions, any bugs or glitches were carefully observed and documented. During these sessions, participants were encouraged to use the application in realistic settings, mimicking the conditions of the 2.4-kilometre run. The students that took the role of "students" took part in the 2.4-kilometer run, while the students that took the role of "teachers" had administrative rights in the test environment, by using the admin application. Feedback was systematically gathered regarding user interface design, tracking accuracy and the overall user experience. Teachers provided valuable insights into the administrative functionalities, highlighting areas for improvement, such as real-time monitoring features. The feedback from these small-scale tests informed several iterative refinements to the application, including enhancements to the GPS tracking accuracy and modifications to the user interface to improve navigation and accessibility. With insights from the small-scale tests incorporated, the application was then introduced into a medium-scale testing phase. This phase involved a larger number of participants from a school, used under real world conditions but tested under controlled environments, providing a more diverse range of feedback and testing the application's performance under varying conditions. The performance of the application was closely monitored, particularly its scalability with increased user numbers and its stability in different environment conditions. The last stage of the iterative design process involved refining the application, based on medium-scale testing inputs, and preparing it for large-scale implementation. Further meetings were held with educators to fine-tune the solution, ensuring alignment with institutional needs and practices. Once final adjustments were made, the application was rolled out across the school entirely. Post-launch

support was provided and ongoing feedback mechanisms were established to ensure continuous improvement of the application. This culmination of iterative testing and refinements confirmed the effectiveness of the application in enhancing the administration and execution of the 2.4-kilometre run. The iterative design process underscored the importance of collaboration, allowing the development team to create a solution that was not only technically sound but also attuned to the unique educational contexts of Singaporean schools. This approach fostered a sense of ownership among stakeholders and demonstrated the potential for student-teacher partnerships in addressing community needs. A robust feedback loop was established with stakeholders, including teachers, students and school administrators to ensure the solution's relevance and effectiveness. Regular meetings and feedback sessions were organized throughout the development process, allowing stakeholders to express their needs, preferences and concerns directly to the development team. Teachers were pivotal in providing feedback on the usability of the application, suggesting enhancements that could streamline administrative functions and improve the monitoring of student performance. Students, on the other hand, highlighted aspects related to the user interface, ease of navigation and motivational features. This collaborative approach enabled iterative adjustments to the application, fostering a sense of co-ownership and investment among stakeholders in the development of the project. Moreover, school administrators contributed valuable insights regarding the integration of the application with existing school systems, data privacy considerations and long-term sustainability. This continuous feedback loop ensured that the final product was well aligned with the educational and operational goals of the schools involved.

AUTO-ETHNOGRAPHIC REFLECTION

Insights From Students' Perspectives

For many students, transitioning from theoretical learning to real-world problem-solving was a profound experience. Engaging in the mobile application project allowed them to witness firsthand the complexity of translating classroom concepts into viable solutions. As one student remarked, "It's one thing to learn about algorithms in class, but actually applying them to solve a real problem made the learning process much more tangible and meaningful". This hands-on approach required students to think critically and adapt to evolving project needs, fostering a mindset of resilience and adaptability. The iterative nature of the project, characterized by regular troubleshooting and enhancements, further reinforced these skills, preparing students for future challenges in their academic and professional pursuits. The importance of user-centred design became evident as students engaged with teachers and peers to better understand their needs and preferences. Developing a product that was both functional and user-friendly required active listening and empathy – attributes that were cultivated through regular feedback sessions and user testing. A common scenario in application development is tunnel vision, where the thoughts of the developers do not accurately match the real-life scenarios.

By having regular feedback sessions, the developers of the application are required to be receptive to feedback, which promotes active listening. By internalizing external suggestions, the student developers are also required to emphasize and imagine themselves in the scenario of the teachers. A student reflected, "Understanding what the teachers and students needed from our application made us rethink our designs more than once. It was eye-opening to realize that technology is as much about people as it is about code". For example, one such design change was the need to view the student's live running route. Originally, this feature was excluded as it was thought to be power-consuming and excessive. However, it was realized after testing that the safety of students was paramount, and that having a live view would reduce cheating by "GPS Spoofing". Hence, the student development team came up with a solution that updates the route in teacher-specified time intervals. This experience underscored the significance of designing with the end-user in mind, ensuring that the final product truly met the needs of its intended audience. Collaboration was fundamental to the project's success, teaching students about the dynamics of working effectively within a diverse team. As students navigated various roles and responsibilities, they recognized the importance of communication in coordinating tasks and resolving conflicts. One participant noted, "We all came from different backgrounds, so learning to communicate clearly and work together was crucial. It wasn't just about the tech; it was about understanding each other and making sure everyone was on the same page". By developing these soft skills, students were able to leverage their collective strengths, resulting in a more cohesive and efficient team effort. Through the project, students gained a deeper understanding of the socio-cultural impact of technological solutions, particularly within educational settings. They became increasingly aware of how their work could address specific needs and challenges within their school community. A student commented, "Knowing that our app could actually make a difference made us think about how we can use technology to solve real problems for real people". This perspective fostered a sense of civic duty and social responsibility, encouraging students to consider how their skills could contribute positively to society beyond the immediate project. The project's successful deployment and positive reception provided students with a significant sense of achievement and empowerment. Seeing their work come to fruition not only validated their capabilities but also inspired continued participation in STEM fields, as is clear from the following reflection: "Seeing the teachers and students actually using our app was incredibly rewarding. It gave me confidence in my abilities and made me want to tackle even more challenging projects in the future". This empowerment fuelled students' ambition and motivation, encouraging them to pursue further opportunities in technology and innovation with confidence and enthusiasm.

Reflections on Partnership Between Students and Teachers

In this project, teachers played a pivotal role as mentors, guiding students with their domain expertise and logistical support. This shifted the traditional teacher-student dynamic, where teachers moved beyond

their conventional roles of imparting knowledge to become facilitators of learning. One teacher noted, "It was rewarding to work alongside the students as equals, helping them navigate the challenges of the project. I learned as much from their creativity and tenacity as they learned from my experience". By providing strategic advice and resources, while allowing students the freedom to explore and innovate, teachers helped bridge the gap between theoretical learning and practical application. The project prompted a re-evaluation of traditional pedagogical approaches, encouraging teachers to view students as capable co-creators rather than passive learners. This shift in perspective led to more participatory learning environments that fostered curiosity and creativity. Teachers observed students taking ownership of their learning, motivating them to rethink how they could incorporate student-led projects into their curricula. As one educator reflected, "Seeing my students develop and implement their ideas was eye-opening. It showed me that when given the chance, they can achieve incredible things". This realization highlighted the potential for innovative teaching strategies that empower students to take an active role in their education. The student-teacher partnership fostered a collaborative and egalitarian atmosphere where traditional hierarchical boundaries were blurred. Students and teachers worked together openly, contributing ideas freely in an environment of mutual respect and trust. This atmosphere encouraged students to voice their opinions and partake in decision-making processes, leading to innovative solutions. A student shared, "It was refreshing to know that our ideas were valued and considered seriously by our teachers. It empowered us to think outside the box and be more creative". This egalitarian approach enriched the learning experience for everyone involved, leveraging diverse perspectives to drive the project's success. The project's success hinged on the co-design and co-development processes, where students were directly involved in solving real-world educational problems. By aligning academic knowledge with practical application, students were better able to understand the relevance of their studies in a tangible context. A teacher emphasized, "Allowing students to take the lead in this project gave them a unique opportunity to apply their learning in a meaningful way. It wasn't just about theories anymore; it was about making a difference". This integration of academic and practical knowledge enhanced students' learning experiences, demonstrating the value of participatory education models. Throughout the project, sustained relationships and learning opportunities flourished between students and teachers. This collaborative experience built strong foundations of mutual respect and understanding, paving the way for future innovative initiatives. Teachers and students alike recognized the value of their partnership, expressing eagerness to engage in similar projects in the future. As one student remarked, "Working so closely with our teachers created a bond that went beyond the classroom. We're already thinking about what we can accomplish next together". This enduring partnership highlights the potential for ongoing collaboration and innovation, fostering a culture of continuous learning and shared success.

Personal Growth Experience for Students

Participating in the mobile application project significantly enhanced students' problem-solving skills, as they tackled complex challenges requiring innovative and strategic thinking. During the project, students encountered numerous technical and logistical hurdles, prompting them to develop creative solutions and think critically about their approaches. One student reflected, "This project taught me to think outside the box and find solutions in unexpected places. It was a mental workout that pushed me to grow". By viewing setbacks as learning opportunities, students cultivated resilience and perseverance and developed essential traits for overcoming obstacles and achieving success in both academic and professional contexts. Balancing the demands of the project with ongoing academic responsibilities provided students with invaluable lessons in time management and organization. They learned to prioritize tasks efficiently and set achievable goals to meet project deadlines without compromising their academic performance. A participant noted, "Juggling schoolwork and the project taught me how to manage my time better. I became much more organized, which improved my grades and kept the project on track". These skills enabled students to navigate multiple responsibilities effectively, equipping them with essential capabilities for future educational and career pursuits. Throughout the project, students experienced leadership roles, guiding their peers through collaborative processes and developing a deeper understanding of team dynamics. Assuming these roles helped students cultivate interpersonal skills, such as accountability, empathy and communication, which are vital for effective teamwork. One student shared, "Leading my team was a challenging yet rewarding experience. I learned how to listen, delegate and motivate others to achieve our goals". By navigating group dynamics and fostering collaboration, students emerged as more confident and competent leaders, prepared to take on future leadership opportunities. Engaging in real-world application enabled students to explore their interests, strengths and potential career paths. The project provided a platform for self-discovery, allowing students to apply their knowledge meaningfully and connect it to future aspirations. A student expressed, "Working on this app made me realize my passion for technology and innovation. It's made me consider a career in software development". This experience inspired students to seek further learning opportunities aligned with their interests, encouraging them to pursue academic and professional pathways that resonated with their personal goals and ambitions. The project fostered a strong sense of social responsibility among students, as they directly contributed to addressing a community need and realizing the societal impact of their work. Students recognized their ability to drive positive change and were inspired to continue engaging in community involvement and responsible innovation. As one participant commented, "Knowing that our work could help improve our school motivated me to think about how I can make a difference in the world". This commitment to social responsibility encouraged students to leverage their skills for the greater good, instilling a lifelong dedication to community engagement and ethical innovation.

DISCUSSION

As education systems continue to adapt to a post-COVID-19-pandemic milieu, urban transport infrastructure and schools in urban environments face growing challenges. On the one hand, there is increased pressure to facilitate face-to-face interactions, while on the other, extreme cases of 'urban de-centering' (e.g., the migration of residents and businesses to the suburbs, as observed in San Francisco). This paper has sought to describe and document one initiative that could serve as a viable solution for resource-constrained schools to navigate these competing pressures. Given the success and positive impact of the mobile application project within the context of our school, there is significant potential for scalability and broader application in other educational institutions. The iterative process and feedback-driven development model can be adapted to suit various school environments, allowing each institution to tailor the project to meet specific needs and challenges. By sharing our methodologies and experiences, we can help other schools replicate and benefit from similar initiatives, fostering a culture of innovation and collaborative problem solving across the educational landscape. Comprehensive training programs for both teachers and students can help ensure successful implementation. For teachers, professional development sessions can focus on integrating technology into pedagogy, managing student-led projects and fostering an environment of creativity and collaboration. For students, workshops on coding, user-centered design and project management can equip them with the necessary skills to tackle real-world problems. Creating a community of practice where educators and students can share experiences, resources and innovations is pivotal for sustained success. Online forums, webinars and annual conferences can provide platforms for ongoing dialogue and collaboration among schools. This community can also facilitate peer mentoring, where experienced schools guide newcomers through the initial stages of project implementation. Launching pilot programs in a select number of schools can provide valuable insights and refinements before a broader rollout. These pilots can serve as testing grounds for fine-tuning the project framework and addressing any contextual challenges. Regular feedback loops involving all stakeholders – students, teachers, administrators and parents – are essential for continuous improvement and ensuring the project's relevance and effectiveness. Collaborating with educational authorities and district administrations can help scale the project more efficiently. Such partnerships can provide access to resources, funding and policy support, streamlining the adoption process across multiple schools. Educational authorities can also help in evaluating the impact of the project and ensuring alignment with broader educational goals and standards.

Building on the foundational success of this project, future directions could include expanding the scope of student-led technology projects to address a wider range of subjects and real-world issues. Integrating interdisciplinary approaches can provide students with a more holistic learning experience, emphasizing the interconnectedness of different fields of study. Interdisciplinary projects can foster a more integrated learning experience. For example, a project could combine computer science with

history, where students create interactive historical timelines or virtual reality tours of historical sites. Similarly, combining technology with art could lead to projects involving digital storytelling or game design, where students can explore both creative and technical skills. Establishing partnerships with local businesses and technology firms can offer students valuable insights into professional environments and potential career paths. Internships, mentorship programs and collaborative projects with industry professionals can bridge the gap between academic learning and industry expectations. Such partnerships can also provide access to advanced tools and resources, enhancing the quality of student projects. Incorporating emerging technologies such as artificial intelligence, machine learning and data analytics can offer new avenues for students to explore and innovate. Projects involving AI might include developing chatbots for school administration or predictive analytics for student performance. Machine learning projects could focus on personalizing learning experiences for students, while data analytics can be used to make data-driven decisions within schools. Advocating for policies that support student-led technology projects can have a scaling impact. By working with educational policymakers to integrate project-based learning into the curriculum, schools can institutionalize these practices, ensuring that every student has the opportunity to engage in meaningful, real-world problem-solving. Policies that provide funding for technology resources, professional development for teachers and incentives for innovative teaching methods can further support the widespread adoption of such projects. By embracing these future directions, schools can continue to empower students, foster innovation and prepare the next generation for the challenges and opportunities of the rapidly evolving technological landscape.

CONCLUSION

This paper has sought to document an initiative which arose in response to needs expressed by teachers, at least in part due to adaptations obligated upon education systems as a whole in a post-pandemic environment. The project highlights the importance of interdisciplinary learning. The project demonstrated that scalable technology could be integrated across multiple schools to support logistics and safety, while reducing operational burdens on staff. Teachers require training and resources to facilitate student-led projects effectively, making policy support essential for sustaining these innovations. Support from educational authorities and continuous professional development for teachers are crucial for the successful integration of innovative projects into school curricula. Such initiatives ensure that teachers are well equipped to facilitate student-led projects and that these projects align with long-term educational goals and standards, sustaining the impact of these educational innovations.

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