



Water Warriors Living Lab: Towards an integrated “Heartware - Hardware – Software” Approach to Water Management

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Abstract. This paper presents the experience of the Water Warriors Living Lab, a bottom-up sustainable campus action research initiative in applying the integrated ‘Heartware - Hardware – Software’ approach for water management at the University of Malaya since the year 2013. It advances the proposition that a heartware approach is needed to enhance campus sustainability efforts, in addition to the more strategic hardware and software approaches. The paper describes how the Water Warrior’s experience in applying the heartware approach has been a strengthening factor in resolving water conservation issues at the university (specifically in lake management), and discusses important lessons learned to date. Our theoretical and empirical insights can hopefully provide renewed appreciation on how local, organic and humanistic factors can be essential ingredients for the long term ‘sustainability’ of campus sustainability efforts.

Keyword:

Campus sustainability, living lab, water management, heartware, bottom-up

1. Introduction

Water Warriors (WW) is a campus sustainability living Lab initiative currently being run by a group of volunteers and action researchers from the University of Malaya, Kuala Lumpur, Malaysia. We apply the integrated “Heartware - Hardware - Software” approach to help enhance campus sustainability transition in water management at the University of Malaya campus. WW started as a grassroots movement in 2013 through the intellectual support from the Japan-Malaysia research programme on ‘Risk-Based Asian Oriented Integrated Watershed Management’ (ACP-IWM), a bilateral research consortium between Malaysian and Japanese researchers. Since then, it has organically grown into a full-fledged campus sustainability Living Lab in integrated water management (Figure 1).

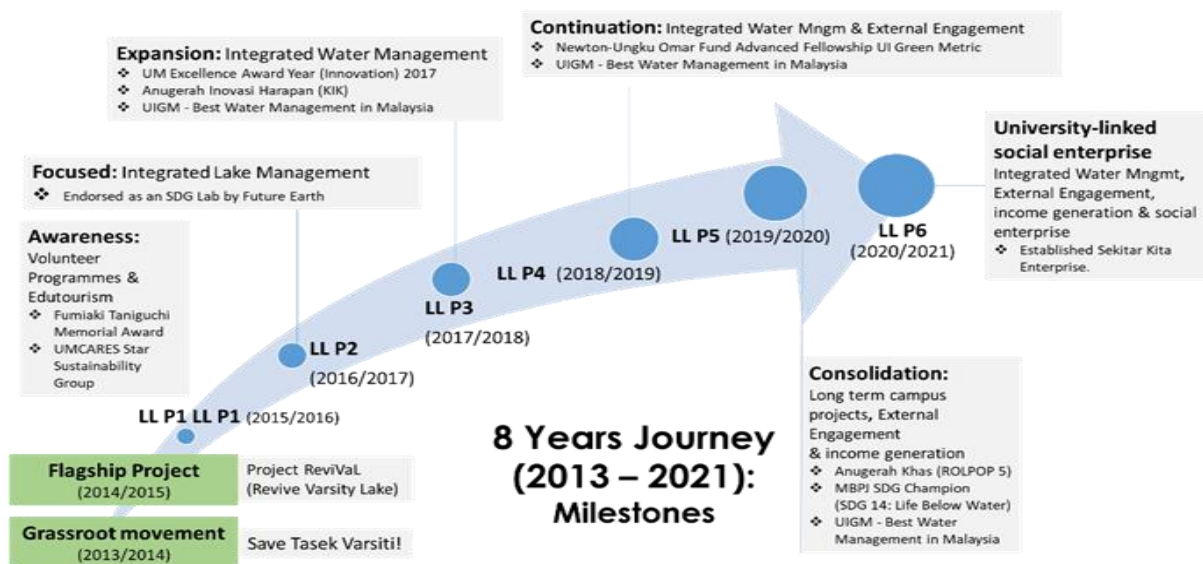


Figure 1. The evolution of UM Water Warriors Living Lab

This article will share our experience in lake management, as one key aspect of our work. Based on our collaborative research with Japanese researchers under the ACP-IWM programme, the team has been exposed to the “heartware – hardware – software” framework as an integrated approach for the sustainable management of lakes [1]. Applying this integrated approach is also unique in campus sustainability work. As we argued in another publication [2] - conventionally, literature on campus sustainability is mainly focused on the management of structured processes, which have resulted in the proliferation of strategic management guidelines, toolkits, handbooks, tools, rating systems and ranking systems to guide campus leaders in facilitating their sustainability journeys. The emphases are mostly on hardware and software approaches - hardware in the form of hard facts i.e., scientific and technological solutions, and software in the form of strategic management of human resources and institutions. Fewer authors have dealt with heartware, which pertains to the internal and organic motivation of the campus communities themselves to establish long-term collaboration and collective efforts for sustainability.

In this action research work, we hypothesized that integrating heartware approaches more consciously in water management strategy can provide a more organic foundation for campus sustainability efforts – in addition to the more structured hardware and software approaches. This paper aims to present our insights to answer this hypothesis from our

experience in consciously applying the heartware strategy in the context of water management in the UM campus. We hope our findings can provide renewed appreciation of heartware (in addition to hardware and software approaches) as an essential ingredient for campus sustainability efforts.

2. Literature Review

The notion of Heartware was first introduced by the International Lake Environment Committee (ILEC) as a part of its integrated lake basin management (ILBM) framework. ILEC is a public interest incorporated foundation/NGO based in Japan and was established in 1986 to promote the sustainable management of lakes and their basins, in collaboration with worldwide counterparts from the academic, administrative and private sectors [3]. ILBM is an approach developed by ILEC to achieve sustainable management of lakes and reservoirs through gradual, continuous and holistic improvement of basin governance, with emphasis on the dynamic integration between six ILBM pillars: institutions, policies, participation, institutions, information, technology and finance (Figure 2). A 2014 Manual by Nakamura and Rast provides a detailed description on this ILBM Platform process.

Based on the lessons gained after fifteen years of developing, implementing and refining ILBM globally has led to a critical realization that maintaining the heartware for stakeholder collaboration is the foundation behind most successful cases of lake governance [4]. Successful ILBM does not only require decisions and solutions on Hardware (science, technology & instrumentation) and Software (institutions, rules and regulation), but also the more humanistic aspects of Heartware to direct and sustain the process of IWM more sustainably in the long run (Figure 2).

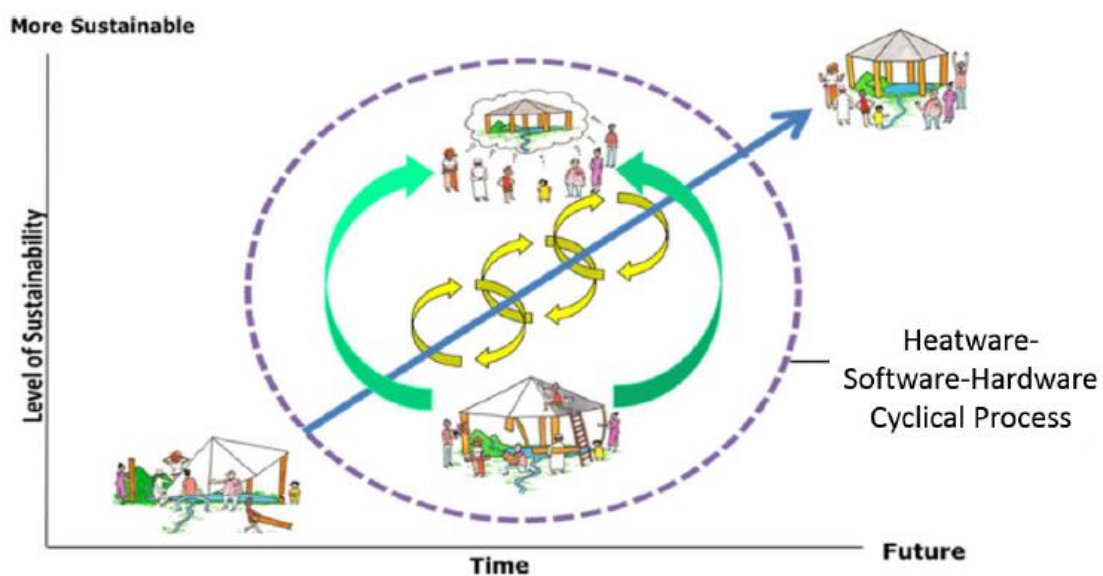


Figure 2. The cyclic platform process in ILBM

Our team’s own exploration of the Heartware approach began when we were inspired to apply the approach in Malaysia [1]. During our visits to Japan, we witnessed real-life cases where a combination of heartware, hardware and software approaches were effectively

applied for IWM in a number of local watershed communities - especially in the surrounding area of Lake Biwa, the largest natural lake in Japan. The heartware approaches observed include the ways in which local traditions, folk stories, unique sense of local community, citizen volunteerism, historical memories of human–nature relationship and deep landscape appreciation have been used to motivate long-term citizen participation and stakeholder collaboration in the protection of the watershed. In addition, the Lake Biwa experience demonstrated the proactive role of local scientists and politicians in creatively using local shared values to develop more holistic approaches for the long-term management of Lake Biwa. Our field observation in Japan eventually inspired our subsequent work in exploring the potential role of the ‘heartware’ approaches for integrated watershed management in Malaysia, particularly for the Selangor River Watershed. The approach was later adopted to the management of water bodies in the UM campus through our advocacy and action research work under Water Warriors.

3. Methodology

The empirical research of this paper is based on action-oriented, longitudinal and in-depth case study research on the application of the Heartware approach by Water Warrior in the conservation of University of Malaya Varsity Lake. Action-oriented research here means that the authors were personally involved in driving this campus sustainability process since 2013 till today, and therefore has the advantage of providing insights through direct observation and critical personal reflection.

The research strategy is similar to the ‘community arena’ approach suggested by Wittmayer and Shapke [5] in a way that we applied action-oriented research for improving the process of sustainability transitions in a particular community. The ultimate aim in this kind of research is to better understand the internal and external contexts that influence the ability of individuals and local communities to deal with sustainability challenges, while facilitating and learning about processes that can enhance their transformative potential towards sustainability. In this way the dual approaches of sustainability science (the descriptive-analytical approach and process-oriented approach) can be concretely addressed [6]. Wittmayer and Shapke conducted their research in the urban neighborhood of Carnisse Rotterdam, the Netherlands - while our spatial focus is the University of Malaya, an urban campus located at Kuala Lumpur, Malaysia.

The data collection and analysis were based on the development of various activities developed by Water Warriors since its inception. Other than direct observation and continuous researcher-practitioner reflection, various types of data were collected systematically between 2013 to 2020 - in the form of documentations (annual reports, PowerPoint slides, and minutes of meetings) and archival records (e-mail exchanges, WhatsApp messages and Facebook statuses). The analysis was based on the triangulation of these different data collections methods.

4. Results

In this section, the results will be arranged in the form of a narrative of the main processes or activities of our work under the Heartware, Hardware and Software framework, as summarized in following sub- sections. The salient features on the role of heartware in enabling the process will be used as key findings and discussion points in Section 5.

4.1 Heartware

The inception of “Water Warriors” (WW) began in late 2013 when UMCares, a volunteer-based environmental secretariat at University of Malaya (UM) realized the need for water conservation efforts in the campus. Aligning with the interest for water-related sustainability issues, a regular volunteer for UMCares during his undergraduate days and a research officer under the ACP-IWM consortia took up the challenge. After conducting a simple survey on one of the main water bodies in campus, Tasek Varsiti - Affan found that there is a need for an immediate action to be taken to revive the lake. He formed a team with another alumni volunteer and two staff researchers from the ACP-IWM programme who were also the coordinator of UMCares and the programme coordinator of the ACP-IWM program. Afterwards, WW was upgraded as one of UMCares’s flagship projects. Later on, in an effort to improve the lake ecosystem, a biology Professor (Halim) was invited to contribute his expertise. Being an expert in ecology and limnology and supportive of the idea to revive the lake, he became a permanent team member of WW. In 2015 when WW was upgraded to the UM Living Labs project, two of WW’s lead volunteers were appointed Project Officers while one of WW’s most active undergraduate student volunteers became the Research Assistant. A lecturer from the Faculty of Engineering and Faculty of Built Environment were later invited to join WW as the lead researcher on the water consumption and urban landscape aspects of the project, respectively.

The “heartware” aspect for the lake revival began in 2014, inspired by the heartware approach in Japan. The concept of citizen science was applied by engaging student volunteers to conduct water monitoring at the lake and the assessment revealed that it was highly polluted (Figure 2). This transpires the documentation of the volunteers’ hopeful messages for reviving the lake on WW’s new Facebook (FB) page which received positive responses from the UM community. After an incident of a student being bitten by an invasive non-native fish species during a kayak activity, the lake was closed off from any recreational activity. Subsequently, the condition of the lake worsened over time due to algal blooms and indiscriminate disposal of solid waste. A significant indicator that the lake is in a dire environmental condition was the growth of blue-green algae which are harmful to humans and animals (Figure 3). WW felt that an important heartware approach that should be used was early engagement with the stakeholders. WW formed a discussion with the main stakeholders of the lake: Department of Development and Estate Maintenance (JPPHB) and Sports Centre; in charge of development and maintenance for the lake’s surrounding area and recreational activities at the lake, respectively. From the discussion it was apparent that there was no clear ownership of the lake and there was a lack of vision and cooperation among the key stakeholders. Engagement with one of UM top management began when WW was called by the Deputy Vice-Chancellor of Development (DVCD) who was recently appointed at that time. The new DVCD wanted to showcase a larger vision of ‘campus development’ to also include the preservation of the campus intellectual, cultural and natural heritage. WW presented problems occurring at the lake, the results of the citizen science monitoring and possible solutions based on the three ‘-wares’ from the ACP-IWM research experience: hardware, software and heartware.

WW was also inspired by the use of traditional local shared values to drive the heartware of the community in Lake Biwa, Japan and wanted to apply the same strategy for Tasek Varsiti. While documenting through old collections at the university’s Memorial Library, it was found that the lake was part of the university’s heritage with many stories written about it as a centre for memorable communal activities such as swimming, research activities,

commemorations of key events, public clean-ups etc. WW produced a YouTube heritage video titled 'Tasek Varsiti, University of Malaya: Then and Now' which was widely circulated to the community via the internet. The video sparked conversation among the stakeholders and public on the future of the lake, which later developed into community support for its revival and long-term conservation. The DVCD was quoted as saying: "When I saw how the lake looked in the past, it brought tears to my eyes! Simply said, the lake needs to be fixed." The video also popularized the motto: "Tasek Varsiti as the Heart of UM" due to its location at the heart of the campus. The DVCD began reporting the condition and updates of the lake through the campus mailing list, raising the community receptiveness and participation to solve the pollution problems. One of his e-mails was titled: 'Ailing Lake & Heart Breaks: We will fix it InshaaAllah (Islamic expression for God willing).

Other instances of the two key stakeholders not collaborating well was during when the condition of the lake worsened with more than 1000 fish found dead and they were collected separately by JPPHB and Sports Centre. At first, JPPHB had a strong "technical, quick fix" approach and wanted to start fixing the lake immediately. Fortunately WW managed to convince the DVCD to postpone the idea first and lead a roundtable session with all relevant stakeholders to provide a more holistic and long term solution for the lake. The first lake revival meeting was organized by JPPHB for all interested stakeholders. During the meeting, the DVCD codenamed the project as ReViVaL (Revive Varsity Lake) and it was collectively decided that it would be divided into three phases: Research, Fixing and Life. The 'life' phase was considered as the main heartware component of the strategy.

To encourage wider community involvement, a series of gotong-royong (communal clean-up) was organized throughout the year. The "treasures" found during the clean-up were astonishing: car clamps, diskette, sanitary pads, shoes, clothes and many other types of plastic food packaging dated as old as from the 90s. After extensive physical work done to improve the lake (this will be elaborate later in the "Hardware" sub-section), the lake was finally ready to be re-launch and open for public use in November 2014. For the first time, JPPHB and Sports Centre collaborated to make the event a success. The highlight of the event was when the community was invited to participate in a swimming competition. Since then, more collaboration took place between the stakeholders. A program called 'Responsible Lakers' was co-organised by WW and Sports Centre to make the lake livelier again with kayak activities, while at the same time educating the community to maintain the cleanliness of the lake and encourage the community's sense of ownership to the lake. Through the staff's common interest in fishing, JPPHB and Sports Centre collaborated to organize the 'UM Fishing Competition' in 2015 and it became an annual event thereonwards. More "open classroom" programmes were developed to raise awareness and educate the public through programmes such as tree walk, water monitoring, and celebration of World Wetlands Day, World Water Monitoring Day and others.

4.2 Hardware

Since 2013, WW began to support JPPHB by conducting monthly water quality monitoring based on the Malaysian National Water Quality Index (WQI) as a strategic data collection and reporting method to the higher management. It began initially under the six months research phase after the first Project ReViVaL meeting and was continued for the next two years afterwards. In early 2014, it was found that the average water quality at the lake was at Class IV, i.e. polluted and not suitable for body contact. Later on, after extensive work has been done on the lake (as explained below), the average water quality at the lake was improved to Class IIB i.e. suitable for recreational use and body contact in late 2014. The Eco-

Heart Index were used to plot the results of the water quality test into a 'heart' shape – a 'broken' heart indicates poor water quality while a 'full' heart indicates good results.

During the research phase, WW decided to probe further at an on-going construction at Engineering Faculty nearby the lake. It was discovered that there were construction workers living as squatters next to the development and had discharged all their wastewater to a pipe which went into the drain that led directly into the lake sump. As a solution, the contractors were asked to set-up a temporary sewage line. During a dry season in 2014, the fixing phase under Project ReViVaL began by rerouting the wastewater from Engineering Faculty through a series of culvert into a nearby river (Sungai Pantai). Afterwards, work began immediately to drain the lake by fixing the water key and releasing the water into Sungai Pantai, while sediments at the bottom of the lake were also removed by dredging using an excavator. Finally, rip-rap was installed to provide protection against erosion at the bank of the lake and a section of the lake was converted into a wetland area in order to purify the water. As promised, the third phase of Project ReViVaL was to introduce 'life' to the lake. Shelters for duck and geese were built and local fish species were added to provide sanctuary for local species.

After the lake re-launching ceremony in November 2014, an invasive species *Najas* spp. (a quick growing aquatic plant) 'attacked' the lake, covering almost 25% from the total surface of the lake. JPPHB, Sports Centre staff and WW volunteers joined the effort to manually harvest the weeds, while grass carp were introduced and the team managed to reduce the weed significantly. Since then, Tasek Varsiti became an important green area in the campus to be developed and maintained. In 2015, JPPHB improved the public space value of the lake by setting up a tree house, building a new jetty, installing LED lights for night joggers and purchasing new water paddles for recreation (Figure 10). Subsequently, in 2016, WW were given the chance to work closely with JPPHB in coming up with ideas and planning to improve the lake further using UM's budget under the 11th Malaysia Development Plan. Among the improvements made was the upgrading of walkway paths, installation of a new portable floating water fountain to increase aeration, providing new benches and dustbins and plantation of local trees.

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4.3 Software

Among the "software" strategies in 2014 was the launching of Project ReViVaL (Revive Varsity Lake) as a prioritized agenda for JPPHB, organized official stakeholder meetings and the development of an action plan into three phases: Research, Fixing and Life. In 2015, WW was upgraded from UMCares' flagship volunteer initiatives to the Campus Sustainability Living

Labs program under Sustainability Science Research Cluster. Through this, WW was formally institutionalized as an action-oriented research entity. After a year, the management decided that Campus Sustainability Living Lab programme was considered successful and will be continued as a new research programme for the university. In 2016 and 2017, WW expanded its activity to broader water issues in campus by also looking into issues of water consumption on campus and expanding the conservation of water bodies to also include the rest of the campus watershed such as rivers and streams. The vision is to ensure long-term integrated water management on campus to be taken up by the campus management by the year 2020.

Various means of communication platforms were used to disseminate information to allow open communication with the higher management as well as the campus community. Ongoing updates on the current state of the lake are frequently shared on WW's Facebook page, website and campus mailing list. The health of the lake was monitored monthly, represented in the form of Eco-Heart Index and shared with the public using WW website. In January 2016, WW organized a stakeholder meeting to discuss the future visioning for the lake. Overall, the stakeholders agreed that the lake should now transition more sustainably, not only for recreation, but also in maintaining its conservation, historical and educational value. Park codes were developed in the Tasek Varsiti Biodiversity Map as guidelines for lake-users.

5. Discussion and Conclusion

Overall, the empirical evidence from the action research revealed that the Heartware approaches evolved as a dynamic complement to the hardware and software approaches in the conservation of Tasek Varsiti. As shown in Section 4, our action-oriented case study demonstrated that proactively developing heartware strategies can provide the necessary foundation to increase trust and shared motivation among diverse stakeholders to develop effective collaboration in developing hardware, software and further heartware strategies over time – resulting in upward improvement of conservation activities. Through the empirical evidence, we find that three heartware strategies were essential in driving positive evolution of this sustainability effort: cultivation of community shared-values, promoting collaborative culture and addressing conflict resolution.

Community shared values

Community shared values was cultivated as an initial Heartware strategy to encourage community/stakeholder participation and collaboration. This includes:

- By reawakening shared values that are inherent to the campus community at the beginning of the movement. Example: Varsity Lake as a heritage site and cultivating a sense of inner responsibility among the community (staff, students and alumni) to care for the lake.
- By proactively developing new shared values, derived from new inspirations and relationships. Example: Lake Biwa inspired citizen science initiative; Project ReViVal as the DVCs brainchild, Responsible Lakers Gotong Royong activity as a complement to the interest of the Sports Centre.

Collaborative culture

The community-shared values could not be effectively galvanized if values did not inspire the hearts of individuals holding different positions within the university, from the higher management to the masses of staff, student and alumni volunteers. The heartware strategy

of encouraging egalitarian, engaged and transparent interaction between the stakeholders helped to ensure dynamic and creative cooperation to take place by simultaneously combining the strength of top-down and bottom-up approaches:

- **Egalitarian:** the process was driven by a combination of horizontal administrative leadership by the DVCD and by the volunteering spirit led by WW. This resulted in a unique non-hierarchical environment for decision making. This institutional change supported creative and uninhibited knowledge exchange among academics and non-academics, staff and students, young and old and among personnel at different levels of university management. Meetings were usually held in a timely manner with open and frank discussions. This allowed reflective and adaptive deliberation of issues.
- **Engagement:** The Project ReViVal was the first effort by the DVCD to convene all key stakeholders of the lake to develop a collective vision, and to deliberate on what should be done to achieve the vision. The action plan was executed after it received general support from key stakeholders.
- **Transparency:** Both the DVCD and WW provided detailed updates about the progress of the lake and would openly entertain feedback from the community throughout the transition process.

Conflict resolution

The overall sustainability journey was punctuated with a series of conflicts even between well-intentioned individuals within the community, and this could cause a blockage to the journey if it was not effectively resolved. Hence developing a heartware strategy that can provide timely intervention for mediation and resolution of conflicts is crucial. In this case study, three incidences demonstrated different types of conflict management that has been employed:

- **Resolution through transparency and compromise:** The first instance was a conflict of priorities between top-down (DVCD/JPPHB) and bottom-up (WW) perspectives about rerouting the drain from the lake to the river. Draining water to the river was an efficient short-term solution, but unsustainable from a long-term perspective. Although the short-term solution was received with much disappointment by the grassroots movement, the conflict did not cause a collaboration breakdown because the issue could be transparently deliberated due to the high level of trust based on strong shared-values. The final decision was acknowledged, although not fully agreed upon, by all involved.
- **Resolution through honest deliberation and readiness to change:** The second instance was the unexpected institutional shake-up at the end of 2014. The institutional merger between UM's community engagement and campus sustainability units under one roof was initially seen as a positive strategic move by the university. However, it was soon discovered that the bureaucratic set-up was not suitable to support the inter-institutional and organic nature of the campus sustainability initiative. It caused a period of confusion and reduced morale. However, frank reflections and proactive self-organizing efforts by different individuals in the university to creatively develop a new Living Lab programme proved to be useful. This organic institutional set-up was responsible for the expansion of the initiative, including WW, until the present time. This conflict was resolved through honest deliberation and proactive efforts to change and restructure.
- **Resolution through timely investigation and proactive collaboration:** The third instance occurred a few months after the momentous re-opening of the lake. A sudden attack by the invasive plant *Najas* spp, caused massive eutrophication, which had never occurred

before. A new study was conducted, and different solutions had to be experimented with. Finally, two mitigation methods were selected and were successfully implemented through proactive deliberation and cooperation by the key stakeholders.

In retrospect, the role of these heartware strategies in supporting hardware and software strategies can be explained by the head, heart and mind connection in providing deep sustainability learning and action [7]. As emphasized by Shrivastava [8]: “Behaviour changes require, among other factors, emotional engagement and passionate commitment [...] Cognitive understanding alone is not sufficient; managers and students need holistic, physical and emotional engagement with sustainability issues.” The empirical findings are also in line with the ‘spiral model of model of behavioral change’ suggested by Mehlman and Pometun (2013). The model emphasizes the circular connection between information/knowledge, care and action, i.e. when we “care” (heartware) about something, we are likely to look up information about both the problem(s) and possible effective actions we can take to make a difference (hardware and software).

In conclusion, the findings from our work with Water Warriors Living Lab have demonstrated that due acknowledgement on heartware approaches (alongside hardware and software approaches) in campus sustainability efforts will equip those who are involved in the process with a more situated and organic understanding about the power of internal motivation and local values that reside within our campus communities, and how it can enhance their ability to manage their efforts in a more reflective and adaptive manner throughout the whole sustainability journey. It is our hope that this paper has provided useful empirical evidence to demonstrate that this can be realistically achieved, albeit with clear challenges.

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