Loh, C. E., Elia M Hamarian, Lim, L. Y. Q., Lim, Q., & Ng, S. Y. Z. (2021). Developing

future-ready school libraries through design thinking: A case study. *IFLA Journal*.

Advance online publication. https://doi.org/10.1177/03400352211028897

**Developing Future-Ready School Libraries through Design Thinking**

**Abstract**

School libraries around the world need to revitalise their space, collections and programming to continue to be relevant for teachers and students living and learning in an information-saturated, technological global age. Efforts in the rethinking of library usage and design are most effective when they are contextualised and localised, based on user needs and country or school budget. Designing Thinking is a useful approach for schools to understand the needs of their populations in order to design targeted improvements for their libraries' specific users. This article explains how one school collaborated with university researchers to use Design Thinking to re-envision the role and functions of their secondary school library. The evidence collected through the process was integrated into the redesign of an improved library for their students. This article provides a model for evidence-driven school library improvement projects.

**Keywords:**

School libraries, Design Thinking, evidence-based practice, secondary school, Singapore

**Introduction**

In today's volatile, uncertain, complex and ambiguous (VUCA) world, many educational systems are revaluating traditional approaches to handling issues as new needs become more apparent. Individuals need to constantly update their skills and engage with various literacies and technologies to not just consume, but produce new ideas and resources and participate in society as informed citizens (Schleicher, 2018; Schwab, 2017). Reflecting the educational emphasis in many countries, the Singapore education system focuses on the need for 21st century competencies such as Civic Literacy, Global Awareness and Cross-Cultural Skills, Critical and Inventive Thinking, Communication, Collaboration and Information Skills (Ministry of Education, 2018). Furthermore, with the move towards online and blended learning resulting from the recent COVID-19 pandemic, there is greater need to understand the use of technologies for learning (Robert, 2020). The school library as a physical and online space can support schools' efforts to ensure students acquire future-ready skills for a VUCA world. However, school libraries are situated in different contexts and serve different users. As such, it is necessary to ensure that improvements are tailored to each schooling context while taking into account general research and library science principles (Hughes, 2014).

This article explains how Design Thinking can serve as a useful guide for evidence-based (Todd, 2006, 2015) library improvement projects. Design Thinking prioritises the user's needs, taking into account the different stakeholders involved in order to work together (Dym et al., 2005) to solve troublesome issues (Buchannan, 1992; Rittel and Webber, 1973 as cited in Thoring and Müller, 2011). By using Design Thinking as a strategy, school libraries can ensure that library improvement projects, whether on a small-scale or large-scale, can support genuine community needs. In using rapid prototyping as part of Design Thinking to rethink libraries, Meier and Miller (2016) maintain that Design Thinking can allow libraries to be flexible and innovative in a system that requires "tactical changes that improve services, workflows, and

team structure for efficiency" (p. 285). This is something school libraries can benefit from as student needs are constantly changing and school libraries risk becoming obsolete, unless the students' needs are critically and systematically addressed. This article documents the Design Thinking process that was conducted at Cedar Girls' Secondary School (real name used with permission from the school) as part of a university-school collaboration to improve the Cedar school library for its student users, providing an example of how Design Thinking can be conducted as part of the evidence-based process of school library revitalisation.

## Background

### What do students require for Future Learning?

To identify appropriate elements for 21st century success in today's VUCA world, future learning must meet new educational expectations, which cannot be achieved with dated twentieth century resources and competencies (Wong and Wong, 2019). Instead, technology needs to play a key role in supporting future-ready learning. Increased range and speed of access to information is one of many reasons technology is now a necessity instead of a luxury. Schwab's (2016) Fourth Industrial Revolution addresses the extensive ways technology plays in our 21st century lives via

> "our consumption patterns, the time we devote to work and leisure, and how we develop
> our careers, cultivate our skills, meet people, and nurture relationships."

In this post-typographic world of artificial intelligence and datafication, our students need to cultivate developmental skills of "curiosity, imagination, resilience and self-determination" (Schleicher, 2018, p. 2) to thrive.

Twenty-first century competencies have commonly been seen by governments and educators as essential future-ready skills. While there are various frameworks, commonly referenced future-ready dispositions include "creativity, critical thinking, collaboration,

communication, socio-emotional and lifelong learning" (Tan et al., 2017, p. 425). This list of values reflects an overall shift from hard skills that have a higher propensity to become obsolete, to soft skills such as collaboration, independent learning and cultural awareness, in order to achieve 21st century excellence. The sentiment is that the VUCA world requires greater flexibility, resilience and adaptability for future work. Students who are inquirers (Kuhlthau, 2010) are equipped with the skills and knowledge to effectively navigate through the web of information. Andrade (2016) encourages active learning through group-based tasks that, according to Lombardi (2007) must also immerse students in authentic learning to prepare them for the VUCA world.

Thus, 21st century competencies include the capacity to inquire, to search for information, and to collaborate in order to participate productively across often permeable national, global and virtual boundaries. In considering the societal context and pedagogies that help students achieve excellence, educators and librarians can better identify what students require for future learning and therefore provide improved spaces and services to meet those needs.

**How can school libraries support future learning?**

Future-ready school libraries need to become relevant and progressive learning hubs that can exist in the information age (Miller and Bass, 2019). Student learning and achievement in schools are optimised when libraries are well-designed, resourced and staffed (Dix et al., 2020; Hay and Foley, 2009; Lance, 2002; Todd and Kuhlthau, 2005), which is why schools need to constantly evaluate how their school libraries are meeting current learning needs. The application of new technologies in libraries should support and extend the development of future-ready learning, which includes skills of reading, collaboration and research (Loh, 2018). Beyond installing devices such as computers, e-readers and touch-screen readers in the library,

librarians need to attend to how the functionalities of particular devices and technologies support learning rather than just installing what seems fashionable. Tech-savvy school librarians can effectively integrate technology where necessary to benefit student learning (Barack, 2015).

The promotion and support of reading skills and engagement remains a key function of school libraries. The PISA Reading for Engagement study (Kirsch et al., 2002) found that students' wide reading contributes to reading proficiency and the school library can play a vital role by supporting students' access to physical and e-collections (Adkins and Brendler, 2015; Merga, 2019). Students are more likely to want to read when they have access to interesting and relevant material, whether in print or online (Jones and Brown, 2011), which is why school libraries must continue to attend to the book collection and reading programmes. However, research has found that while students are familiar with using technology, using technology for reading may not be their preference in all situations (Loh and Sun, 2019; Evans, 2017; Merga, 2014).

Additionally, libraries should support the development of future-ready skills like collaboration and independent learning through technology. For instance, as schools move towards more collaborative approaches to learning with flipped classrooms and fully online lessons, technologies are necessary to better facilitate group discussions, like shared screens in small discussion rooms. As the COVID-19 school closure has shown, the use of technology is now a key component of student learning. Skills such as self-directed learning and online collaboration can also be supported through technology. Knowledge of learning management systems (Karplus, 2006), social media (Barack, 2015) and search engines are some of the necessary tools a librarian must learn to work with in order to engage with users. Information literacy has always been a key focus in school library research (Kuhlthau, 2010), but the educational conversation now needs to account for developments in digital technology and

environments, and the role of youths and learning in these fast-changing contexts (Dresang and Koh, 2009).

**Design Thinking and user needs for future learning**

Design Thinking, which allows for a thorough needs assessment, is one way to integrate the student-as-user perspective into the redesign of a school library for systematic evidence-based (Todd, 2006, 2015) improvement. In a compilation of works aimed at encouraging teachers to rethink their digital age pedagogy, Laurillard (2013) urges teachers to consider learning "through the lens of the learner" (p. xvi) to get a glimpse of the learner's experience. In Design Thinking, the same logic applies to the researcher and the user; the former must consider the user experience when executing the design. Wong and Wong (2019) call this stage *Empathy* while Brown and Wyatt (2010) call it *Inspiration*. In this stage, researchers consider the users' motivation to use and experience the product/service. The design of future-ready school libraries should ensure that school library resources and services fulfil genuine user motivations, at ground level.

Design Thinking essentially heightens sensitivities to the uniqueness of the problem and pays extra attention to the user experience. While there are many methods for Design-Thinking, Wang and Hannafin suggest that contextualisation is key (Peer Group at the University of Georgia, 2006) as it emphasises the "unique cultural context" (Brown and Wyatt, 2010, p. 32) of the users, situating the user journey as critical in understanding the needs to be addressed. When mapped out, the user's journey is represented so viewers can understand the "various stages, steps, and touchpoints a user must pass through in order to complete a task" (Marquez, Downey and Clement, 2015, p. 36). Through cultural immersion and charting their journeys, the researcher is better equipped with knowledge to make well-informed decisions pertaining the users' needs. In a study using Design Thinking to redesign the school library,

Barrett (n.d) finds that all parties must fully comprehend it to establish fully functional spaces for the user.

Writing about academic libraries, Meier and Miller (2016) refer to the Institute of Design at Stanford's Design Thinking strategy as a way for libraries to approach change. The emphasis on users' needs, getting different stakeholders involved in order to work together (Dym et al., 2005) to solve troublesome issues (Buchannan, 1992; Rittel and Webber, 1973 as cited in Thoring and Müller, 2011), and the use of rapid prototyping to test out ideas to assess the suitability of proposed ideas support targeted and appropriate school library transformations. This collaboration between field experts and users ensures that library design will provide products/services required by students to encourage the development of their 21st century competencies.

This article illustrates how one school used Design Thinking to unearth specific user needs in one schooling context, specifically in relation to the use of technology for the future-ready skills of reading, collaboration, research and study. We explain how Design Thinking was used to rethink the role and functions of one secondary school library to redesign a new evidence-based library for its target users, providing a model of action for other schools and libraries. We focus specifically on the empathy stage of Design Thinking, demonstrating how evidence can be collected and used for idea generation and further action. Furthermore, what is unique about this study is that much of the data was gathered by students and takes the perspectives of students as core, rather than taking the views of teacher-librarian or educators (Hughes, 2014).

**The Design Thinking context**

Between 2017 to 2019, the *Building a Reading Culture* study, a baseline study of reading and school libraries, generated insight about the design of school library spaces, collections and

programming to support future-ready learning within Singapore (Loh et.al., 2017; Loh 2018, 2020). Chin Ee (Author 1) provided consultation for three secondary schools (including Cedar Girls' Secondary School) that were in the process of redesigning their school libraries, drawing from contemporary school library research and her study findings to inform the data collection and analysis, and integrate the findings into the redesign of the physical school library space. Chin Ee worked closely with Cedar Girls' Secondary School in 2019 to collect survey, observation and documentary data, and used the data to inform the re-design of the school library space, technology use and programming. Due to the COVID-19 situation in 2020, the library design and renovation work was halted and restarted only in January 2021. Instead of the initial target of mid-2020, the library renovation project deadline was shifted to end-2021.

Cedar Girls' Secondary School is an all-female secondary school (ages 13-16) that offers both programmes in the Express stream course: the four-year GCE 'O' Level Programme, and six-year Integrated Programme (IP) that culminates in the GCE 'A' Level examination (Ministry of Education, 2020). IP caters to students with strong academic performances in the Primary School Leaving Examination and aims to maximise the students' academic potential. The school has a special focus on Social Innovation that features spaces and programmes to nurture a sense of involvement and agency towards societal matters. The school is also supportive of creating a collaborative culture.

Within the Singapore context, qualified librarians are not typically part of the school library ecosystem. Instead, a qualified teacher is appointed as a library coordinator. The Ministry of Education also provides funding for the library system, library assistant and an annual per capita book grant. At Cedar Girls' Secondary School, a school committee made up of teachers from different departments (referred to as the Library Task Force) was set up to spearhead the revitalisation of the school library. In addition, a group of four students including Lisa, Qianwei and Skyler (Authors 3, 4 and 5) volunteered to form a social innovation team

(hereafter referred to as the SI team) to examine the library usage and needs of the students through a survey and informal interviews with their fellow students. These students volunteered to do the project outside of their school curriculum because of their genuine interest in improving the school library.

At the National Institute of Education, pre-service teachers are expected to participate in an Education Research module of their choice as part of their learning. Elia (Author 2), a pre-service teacher, joined the study mid-way, and worked with Chin Ee to conduct user journeys to collect evidence on student learning, specifically in relation to reading and technology. All authors contributed to data collection, data analysis and the writing up of the research for this article.

**The empathy stage: Collecting evidence to inform design**

Design Thinking highlights empathy as an approach to holistically consider the user needs and experience through cultural immersion and/or observation of the users' circumstances that affect their interaction with the product/service. While systematic, it is also flexible. Finally, Design Thinking encourages collaboration among experts of various fields to ensure the product/service can cater to the needs to the users. For ease of communication with the school and implementation, we referenced the five steps in the popular Design Thinking model by Stanford Design school (Hasso Plattner Institute of Design at Stanford, 2021), when implementing the different stages of Design Thinking. The five steps are (1) empathise, (2) define, (3) ideate, (3) prototype and (e) test. This article documents the empathy process where data collection and analysis helped the students and researchers to understand the users' (students) needs in order to define the problem, allowing students, teachers, the school leaders, researchers and architects to brainstorm possible ideas for library redesign to be integrated into the library renovation project.

**School-driven data collection: User survey and observation data by the SI Team**

The SI team volunteered to work on the library revitalisation study to collect data as part of the Empathy process. There were two stages: in the first stage, the students visited various school and public libraries to understand different library roles and functions and to gather ideas. In the second stage, the SI team designed and implemented a survey which was sent via email to all Secondary 1 to 4 students, with the main objective of finding out about their fellow students' likes and dislikes of the current library, their vision of a dream library and the kinds of books they would like to see in the library. In total, 893 out of the total school enrolment of 1186 students (or 75% of the school enrolment) completed the survey. The SI team also spoke informally to their schoolmates about their findings and preferences to better understand the survey results.

The multiple-choice questions were adapted from a reading survey (Loh and Sun, 2018) and centred around the students' enjoyment of reading, opinions of the school library collection and space. The multiple-choice questions provided insight into trends and preferences. Open-ended questions were asked at the end of the survey to solicit students' honest opinions and suggestions for improvements. The SI team also used an excel spreadsheet to code the open-ended questions for emergent themes. Finally, they created a presentation of their findings to share with the School Library Task Force and university researchers. Input from their survey was used to inform the re-design of the school library space.

**A university researcher in the school: User Journey and interview data**

Elia used user journey maps and interviews as part as part of the Empathy process of Design Thinking to complement the SI students' survey study. As an impartial observer and pre-

service educator with understanding of the curriculum needs of schools, Elia could provide another perspective on the needs of the school and students. Two students were selected by the teachers as participants. Only two students were shadowed for two reasons. Firstly, the nature of Design Thinking entailed a greater attention to the idiosyncrasies of the users' needs and experiences at the empathy stage. A general idea of the users' attitudes and needs were attained form the survey; however there needed to be more attention to the particularities of the user profile. As such, a smaller number of participants would be most useful to carefully assess the personas, pain points, challenges and decisions of each participant. We juxtaposed the analysis of this data against informal observational data and the survey data to draw more in-depth understandings of students' responses to and use of technology. While not representative, it provided insight into actual usage to complement the large-scale survey data. This would better define the problem, thus resulting in a more quality ideation. Secondly, due to the unexpected COVID-19 pandemic which resulted in a school lockdown a few weeks after the user journeys, logistical issues were considered when deciding on the number of participants. To account for safety measures and minimal external contact with students, we agreed with the school to shadow only two participants.

Annie (pseudonym) is a year 2 library-goer. Paige (pseudonym) is a year two student non-library-goer. Both identified as readers. Data was collected from a single full-day observation of each student conducted in March 2020. As the period of data collection happened during the COVID-19 outbreak, students were encouraged to leave school after lessons and all non-curriculum activities were suspended. The library also limited its admission of students. The new environment may have compromised the authentic depiction of both students' daily interactions with technology and the library.

Observations, meant for Elia to better understand the needs of the participants, occurred across all spaces the students visited such as the classrooms, canteen and library. The students

were observed for their interactions with reading, technology and possible opportunities for library support. Field notes were taken. Due to the participants' tight schedule, interviews were conducted whenever possible throughout the day. The interviews were done to clarify follow-up questions from observations and to pose other background questions relevant to understanding the students' interaction with and perceptions of technology, libraries and reading.

Data was presented in the form of user journey maps which are infographics that provide insights into the user's experience. The maps also provide viewers with a simplified understanding of the areas pertinent to the use of technology and opportunity for library support. The user maps, together with the interviews, were coded thematically for insights into student library, and student technology use and needs.

**Findings from the Design Thinking process**

**Survey findings**

***Lack of varied and popular books***

The survey showed that 33.4% of the students considered themselves non-readers or ex-readers who used to read, but did not do so anymore (Figure 1). For students who read, they stated that they obtained books from places other than the school library. Reasons cited for this include the lack of variety as well as the lack of new and popular books. Both groups of students who only borrow books from the public library and only buy books from bookshops cited the "most recently published books" and "popular books" as the two main reason for using the public library and bookstores as preferred sources for obtaining books. In addition, in a free response question, 130 out of 220 respondents who only borrow books from the public library explained that they choose to borrow books from the public library because it had more variety compared to the school library.

**Figure 1.** Reading habits of students.

Reading habits of students



**Figure 1.** Reading habits of students.
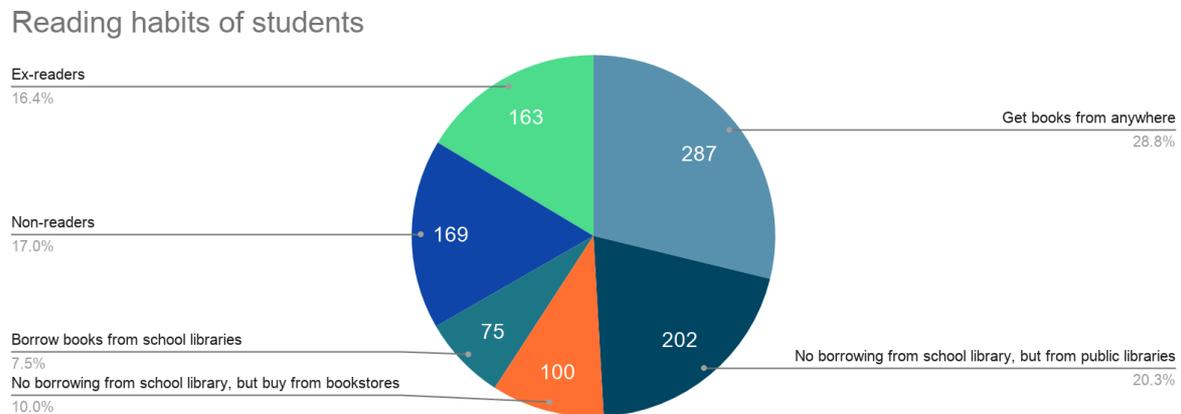
*Common uses of the school library*

Next, the survey showed that studying, relaxing and printing were the most common uses of the school library (Figure 2). The library was paradoxically both a place for work (studying) and play (relaxation). At the same time, students made use of the facilities such as the printers for printing and the space for group projects. Informal interviews with the students found that they enjoyed the air-conditioning in the library and found it conducive for studying. The printers in the library were also useful for last-minute projects. Students shared that they did not have home printers or that if they had home printers, it often ran out of ink or broke down. The school printer was therefore a reliable source for them to print notes they had created for self-study or for assignment submissions.

**Figure 2.** Preferred usage of library space.

Usage of spaces in Library
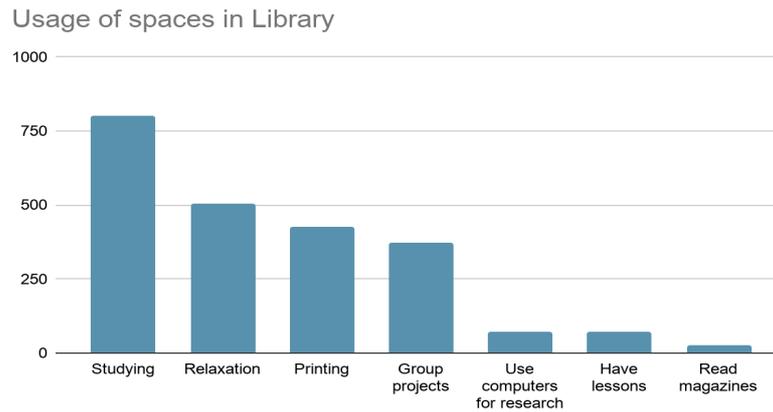


For studying, students preferred bigger tables, more natural light and more comfortable or bigger chairs (Figure 3). Given the academic pressures of being in a top girls' school, it was unsurprising that studying remained a top priority. However, students were also likely to use the library for group projects, suggesting that collaboration was important in the work they were allocated. However, they did not really use the computers for research. It may be that many students used their own laptops or mobile phones for research, as the user journey maps showed.

**Figure 3.** Study preferences.

Method of improving comfort of studying spaces
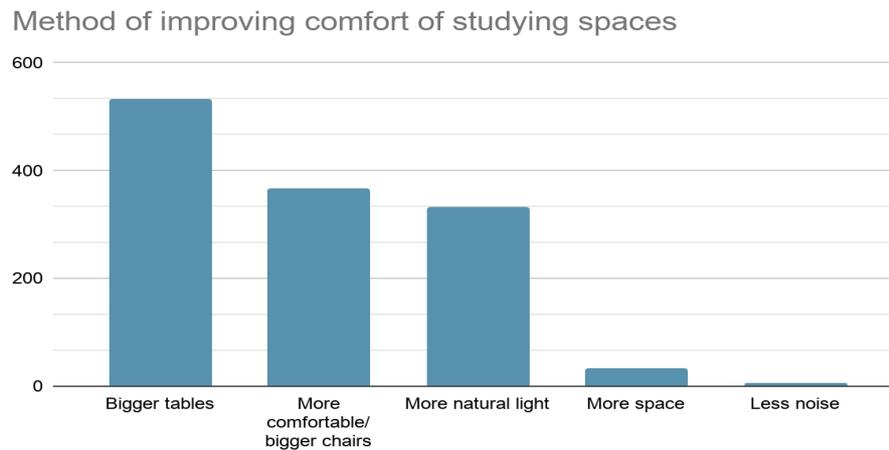
For studying, the students preferred personal studying cubicles to normal studying spaces (Figure 4), with 64.7% asking for personal studying cubicles. Informal interviews also revealed that while the girls desired individual study spaces, they were happy to visit the library with their friends to have company while studying or relaxing.

**Figure 4.** Preferred Studying Environment.

Preferred studying environment
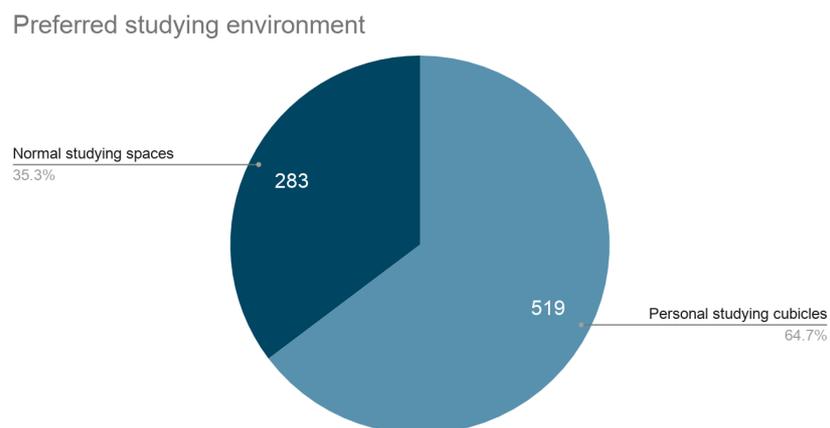
The students were asked if they used the library to search for information, and results showed that it was not a popular place for this activity (Figure 5). 71.6% of the students reported that they did not go to the library to look for information when doing research.

Based on observations and informal interviews with students, it was because the library, similar to most school libraries in Singapore, did not conduct information literacy or research lessons. As mentioned, most students used their own devices for research, whether during or outside class time.

**Figure 5.** Use Library to Look for Information.

Do you visit the library to look for information (e.g. when conducting research, etc.)?
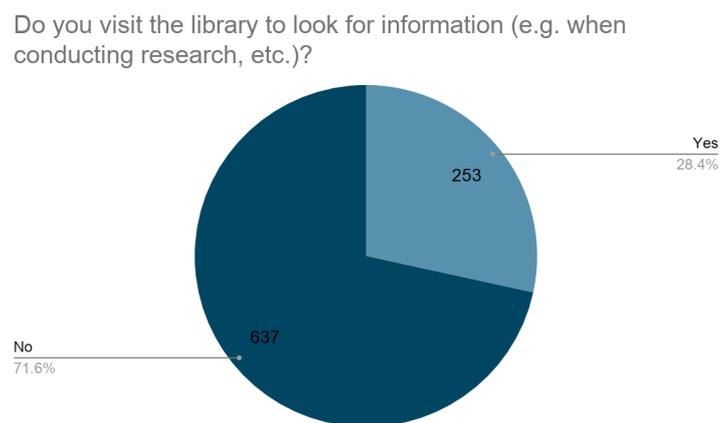


*Library and technology*

Within the Singapore context, the National Library Board (NLB), the Singapore public library system, had made accessibility to e-resources available through the NLB App since 2016 (National Library Board, 2018.). All Singapore students are entitled to free public library membership. Although 73.3% of the survey participants reported that they were NLB members, only 37.9% reported having the NLB mobile app, which allows for e-transactions and the loan of eBooks (Figure 6).

**Figure 6.** Number of students with NLB Mobile App.

Do you have the NLB mobile app?
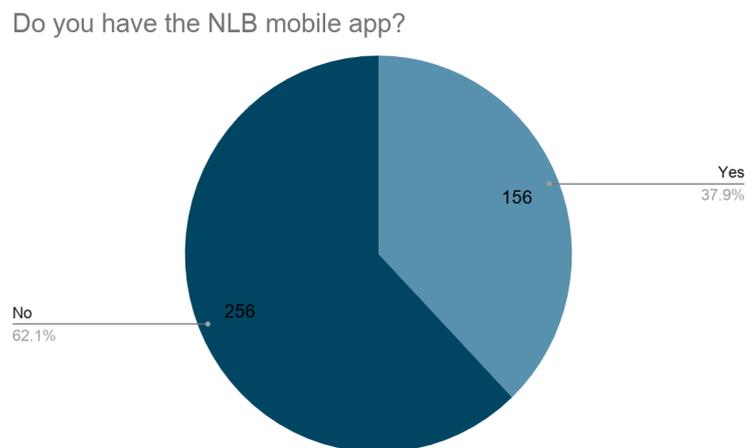


**User Journey findings**

This section reports on the findings from the user journeys maps of two students. Each student's data is presented as a timeline, focusing on significant interactions with technology and the library. Highlights from the follow-up interviews are used to supplement the findings from the observations and to inform readers about the participants' perceptions of future-libraries. The journey maps were selected as the mode of presentation as they were helpful in tracking the users' day-to-day experiences with technology and library. The maps also allowed for specific details to be highlighted as pain points or critical areas that affected the difference in decisions and behaviours for the users, which helped the researchers to define the problem and to ideate meaningfully. We attended to both reading and uses of technology as significant areas that the school wanted to better understand. This sets a clearer context for the researchers when ideating.

*User Maps*

***Annie: Year 3 Library-Goer.*** Figure 7 shows Annie's activities on Monday from 0735hrs to 1515hrs.

**Figure 7.** User Map timeline of Annie
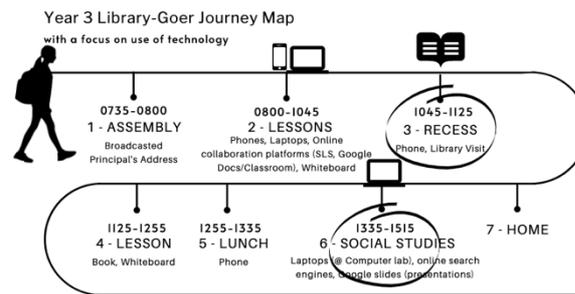


The use of technology for online collaboration was significant in two lessons. From 0800hrs to 1045hrs, Annie's English teacher used Google Docs to facilitate groupwork. Since the students could not physically gather, they accessed the web-based word processor Google Docs from their desks and worked together online. The teacher could access all the groups, track each member's contribution, and comment immediately. Online collaboration was also observed in Annie's Social Studies lesson conducted in the computer lab. In groups of four, students were instructed to independently research and present facets of good governance. Annie's group searched various sources, collecting articles, case-studies and definitions. They used the Google search engine for their searches, then transferred their findings onto a shared Google Doc to filter information by discussing the credibility of the articles found. They then transferred their presentation ideas onto Google Slides, the platform set by their teacher, and shared it with their teacher to screen on the main projector for their presentation. Some students seemed more concerned with content and others with aesthetics of the slides. A majority of the slides across the class had excessive amounts of text and only one group referenced sources.

Another common form of technology used throughout the day was the whiteboard. Although the traditional whiteboard may be considered a traditional form of classroom technology, it still remains highly relevant in the school, with extensive use by four of Annie's teachers. Only her Social Studies teacher did not use it.

Not many students appeared to use laptops. During the English lesson, only one student opened her laptop while the rest used their mobile phones. During the Social Studies lesson, some brought their own laptops to use, while the majority used the laptops provided in the computer lab. On the use of personal laptops, Annie commented:

> "...It is compulsory for everyone to get [it]. We usually only bring our laptops if the teacher asks us to because it's really heavy. Most of the time we just use our phones but if we have a bigger project to do, then we'll use our laptops because it's easier to type with everyone."

Annie's comments revealed that while laptops are compulsory, most students prefer their phones because they are lightweight and can serve similar functions as a laptop, which seems to be used only for large-scale active collaboration and projects.

Annie's visit to the library during recess was particularly significant. Annie, who usually visited the library to study, had borrowed a book from the school library. She wanted to borrow its sequel but did not know if the library had it in its collection. She struggled to find the book as she did not remember the author's name and revealed to Elia that she did not know how to approach the librarian for help. She explained she did not know how to look for book titles and did not know how to borrow or buy eBooks. She preferred print books as she wanted to keep them as her own.

During the follow-up interview, Annie told Elia that she had visited the new Harbourfront public library and was intrigued by the new technological features such as eBooks and laptops for online magazines. She looked forward to "easily accessible technology for all ages" in future libraries. She explained her personal challenge in using the library:

> "Maybe clearer explanations as to how to use technology in terms of education. Technically we can use the computers to research and find research journals but don't

know how. The computers there are really old…I suppose I could ask the librarian but there aren't instructions there that are widespread for us to find information"

Annie's struggle with seeking help with finding books and online resources transcends just knowing how to use the computers and finding research materials. It highlighted the lack of effective signage and technology in the school library that could support her needs. Additionally, Annie also expressed wanting personal study spaces so that she would be able to do her work uninterrupted.

*Paige: Year 2 Non- Library-Goer.* Figure 8 traces Paige's activity on Wednesday. She had a full curriculum day; however, the last two periods (i.e., 1335hrs-1515hrs) were her Form Class periods. Unlike Annie, Paige did not usually visit the school library. Most of her breaks were spent in the school cafeteria with her friends, using their mobile phones for leisure. The school had a relaxed mobile phone policy and students were allowed to use them when not attending class.

**Figure 8.** User Map timeline of Paige
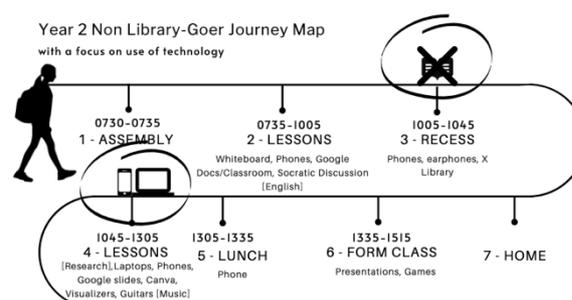


Paige's experience with technology also involved whiteboards, visualisers, Google Docs, Google Slides and other platforms like SLS (Student Learning Space), a MOE learning management system adopted by the school. Traditional technology like whiteboards and

visualisers were used in her Biology and Math lessons. More handouts were issued for these subjects, and students used the whiteboard to present their work, while the visualiser was used to present the teachers' answers. This was also common in Annie's Math lesson where students were invited up to the board to share their work.

In contrast, laptops were used extensively for multiple purposes in Paige's Social Studies and English lessons. Paige's experience with using of technology for online collaboration was similar to Annie's Social Studies lesson. During a research lesson, the students were tasked with a group activity that demanded them to collaboratively research on a topic for their project work. Paige's group was researching on 'Ethnography'. Although supposedly a discussion, there was not much dialogue happening. Instead, four out of five students, including Paige, were on their phones working together on a Google Docs page, contributing their findings. Unlike Annie's class, Paige's class had at least one laptop per group, although the majority still used their mobile phones.

Elia noticed one member from Paige's group browsing *Encyclopaedia Britannica* online for information while the rest of her group members were on other webpages. When the student was asked why she preferred *Britannica*, she explained her father had taught her to refer to it, like how he taught her to use *Canva*, a design platform, for presentations. The rest, including Paige, appeared unfamiliar with *Canva*. Paige shared that they would all organise their points on Google Slides, which was accessible to all. Finally, the student who knew how to use *Canva* would transfer everything onto it.

Paige's English lesson also utilised technology for online learning. Her teacher used the SLS platform to simulate a livestream flow of comments from an elaborate Socratic discussion. Students were paired up and given the role of speaker and scribe. The scribe had to note down their speaker's points and upload it onto the SLS page, which was screened on the main projector for everyone to see.

The second area of interest into Paige's day was her conscious decision not to visit the library. Paige explained she frequently visited the school library in her primary school and avidly read the books in its collections. However, she stopped visiting the school library in secondary school due to her busy schedule. Furthermore, she limited visits to the school library because of the noise. The peak hours of library traffic (i.e. recess and after school) could be very noisy, according to Paige. Hence, she only visited the library during rainy days when the study benches in the school's corridor spaces got wet. Insufficient study spaces and noise levels were also something Paige was concerned with during her follow-up interview. She expressed a preference for outside-library spaces to study due to the library's non-conducive environment. Lack of time was also mentioned as a factor for her sporadic visits to the library, as she was facing an increased workload. Since she has a personal laptop and mobile phone that she uses for her schoolwork, this reduces the need to visit the library.

When asked how she gained access to books, Paige replied,

"When I want to borrow books from the [public] library, I usually borrow the eBook, so I can read it on my phone…. because it's easier and very convenient. I don't need to wait and reserve a book because there's a waiting list, but it'll be automatically delivered. But I also prefer buying books because I like to have a collection."

Paige did not have issues with books or reading, but was unsatisfied with the services and the environment of the school library. Instead of borrowing physical copies, Paige expressed a preference for eBooks which she considers "convenient", as she need not wait for her book.

## Discussion

The findings revealed several key points about how the library can be improved to support the learning needs of adolescent students in Cedar Girls' Secondary School. In this section, we

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discuss how the school library can be redesigned for (1) reading, (2) research, and (3) collaboration and study.

**Redesign for reading**

The main finding from the survey was that the library was perceived as not having attractive and relevant book collections to support student reading. Furthermore, Paige elaborated that she was able to get book resources from the public library and bookstores, supporting the findings from the survey that students who were avid readers could get their books from elsewhere. Even though Annie was an avid reader, she was not aware of how to get eBooks or to ask the librarian for help. This is reflected in the survey data where the majority of the students reported not using the NLB app, which would have allowed them to access eBooks freely and easily. Based on these findings, the School Library Task Force is also working on improving its book and e-collection in tandem with the physical library renovation, to better meet the needs of the students.

With more students gaining access to applications like Goodreads, Kobo and Kindle, their interactions with eBooks are more widespread (Atanasovski, 2018). However, current research show that while avid readers are likely to utilise eBooks as well as print books to feed their reading habit, many students still need to be taught how to use eBooks (Loh and Sun, 2019; Sun and Loh, 2021). Since public libraries already make eBooks accessible, the school can support students' access to these public resources by educating students like Annie on how to go about borrowing them and even set-up an e-collection system that mediates the borrowing from public library to students. Particularly, the experience of COVID-19 showed that it is essential for librarians and school libraries to help students access eBooks, especially when physical books are not available, in order to extend their reading resources. Online tutorials on how to use eBooks, e-programming and online promotion of books are even more necessary

to keep students reading (Witteveen, 2020) and should be integrated into the school's library programming.

Secondly, while the library already has an online access public catalogue (OPAC) system to make searching more convenient and faster, it was not made visible to the students through a OPAC machine. Annie's experience showed that it was not easy for students to find books in the library or know who to ask. The students could access the online system by logging in on their phone or laptop, but they could be unaware of how to use it, suggesting that instruction and frequent reminders are required for simple routines. Lonsdale's (2003) call for a more technology-relevant school library and technology-equipped librarians rationalises the need for an online system. Annie's experience also highlighted the importance of a helpdesk and posters informing students of the various functions and resources available for them. Big, bold signs drawing students' attention may ease their user-experience if they require help, creating an environment of support and user-friendliness in the library.

**Redesign for research**

Paige and Annie's experiences revealed many instances of research and collaboration, suggesting that research is an integral part of the school curriculum. This puts the school on Kuhlthau's track of inquiry-based learning (2010), instilling future-ready skills relevant for students to flourish. With the establishment of research libraries (Research Information Network & Research Libraries UK, 2011), the school can also increase features that improve the research process. The increased reliance on digital information in this day and age means that students need be skilled and critical users of digital information. The user journey showed that students did not necessarily have knowledge of different ways to search for information, often relying on the Google Search Engine. Paige's knowledge of *Encyclopaedia Britannica* resulted from her home rather than school education. This suggests that there needs to be a

stronger information literacy curriculum (e.g., The FOSIL Group, n.d.) in the school to help the students learn to navigate the internet for specific kinds of information. Although the students may be digital natives (Prensky, 2001), they may possess uneven knowledge and access to different ways of searching and evaluating information (Coiro, 2020; Selwyn, 2009).

Other resources that the library may subscribe to or integrate into training are sites like *Canva, Google Scholar, Refseek, iSeek, Infotopia or Microsoft Academic* that can be made accessible upon logging into library computers. Introducing these presentation or research sites to students, curating customised research tools and developing more targeted research skills programmes can help students develop their presentation and research skills. Given the increased emphasis on collaboration, the capacity to present research and ideas will facilitate students learning to communicate effectively with others. At present, the School Library Task Force has started work on curating e-resources to support their students' learning needs. The School Library Task Force can also work with the research department to find ways to support the curriculum needs of the school in terms of updating its resources, though this is likely a difficult task as Singapore schools are not staffed with full-time qualified librarians or teacher-librarians who can collaborate with and support the development of a structured research and information literacy curriculum.

**Redesign for study and collaboration**

The survey findings showed that students used the library most for studying and also used it regularly for group work. The findings also suggest different patterns of behaviours that point to the need for a flexible approach to meet the needs of diverse users. While some students liked to go to the library to study together, others like having quiet workspaces. This is borne out in the survey where a majority of the students requested for private study cubicles. This suggests that study carrels or the partition of spaces to give a semblance of a

personal space for each student will support students' individual silent studying. Students' requests for more conducive spaces implies that a change in the physical layout of the library can better support their study needs.

Based on this feedback, the redesign of the Cedar Girls' school library aimed to integrate two discussion rooms in the lower level of the library and reserve the upper level of the library for studying. Before purchasing carrels, the school decided to rearrange existing tables and chairs on the second level of the library to facilitate quiet study as a form of rapid prototyping (Meier and Miller, 2016) to test the idea and to lower the cost of innovation. This zoning of the library into a noisy zone in the lower level and a quiet zone in the upper level will allow for seamless movement between the different ways of learning across different parts of the library. Since students also use the library for group work, it would be helpful to provide learning materials and technologies such as flipcharts, whiteboard markers and whiteboards to facilitate student work. These tools for brainstorming can facilitate student collaboration by providing a space for the group-think. Projectors or touchscreen televisions can also facilitate student collaboration and sharing through projection of their work.

**Conclusion**

The findings from the study informed the design for the physical renovation of one school library, to create spaces in the library for the future-ready functions of reading, research, collaboration and study. The design will be accompanied with improved book collections and programming that aim to improve student access and use of the library for the development of their future-ready skills. At the same time, there needs to be meaningful use of both older (whiteboard, print books) and more recent technologies (eBooks, e-subscriptions) to support students' future-ready learning. As shown in the findings, "older"

technologies such as whiteboards continue to be significant for brainstorming and collaborative work. When it comes to figuring out how technology can serve students' needs, collaboration between teachers, librarians and teachers can allow for better decisions to be made regarding resources and methods (Lance, 2002; Montiel-Overall, 2010). School and public library collaborations are also a way for school libraries to draw on public resources and materials for the common goal of student learning (Moreland and Kammer, 2020), particularly in times of reduced budgets and limited resources. However, it is crucial to note that space redesign must be accompanied by shifts in collection policies and programming (Loh et. al., 2017), a journey which the Cedar Library Task Force is continuing on even as there are further changes in the Singapore post-pandemic educational landscape.

While certain principles may remain core to the work of school libraries, each school needs to consider its student profile and priorities, in accordance with budget constraints and empirical research to ensure targeted and relevant improvement. This article has demonstrated how Design Thinking processes can be used to understand the user (in this case, the student). It offers schools interested in redesigning their library space a systematic way to involve their students in the process of gathering data and identifying school-level needs for their library improvement projects. Design Thinking can be applied to the various areas of school library improvement. For example, schools can meaningfully monitor the types of books with high and low frequency borrowing, generating patterns from data that can better inform what kinds of resources are valued by students. At the same time, school libraries can also gain student perceptions of the library and how it contributes to or complements their school life, which empowers them with useful information to strategize follow-up actions. Design Thinking can be used for small hacks and improvements or large-scale transformations. Ultimately, the aim of using Design Thinking is to ensure ongoing

evidence-based library revitalisation for the continuous improvement of school libraries to support reading and learning.

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