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PAPER

Curating an Offline Wikipedia for Schools in any Language: A Road Map

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ABSTRACT

Around the world, rural and remote communities face a myriad of challenges in providing quality education, especially in communities where internet and electricity access are unreliable or nonexistent. Many innovative projects and initiatives have attempted to provide technological solutions adapted to the infrastructural challenges in these unconnected areas. One such innovation, the offline digital library (ODL), has emerged as a promising and cost-effective solution for bringing information to offline locations without the need for massive infrastructure overhauls and costly ongoing maintenance. Despite the existence of numerous ODL initiatives and the critical importance of library content being relevant to its users, the process of curating collections for ODLs has not been sufficiently discussed in the scholarly literature. Using the SolarSPELL initiative as an ODL model, this article seeks to illuminate the process of curating an offline, customized encyclopedia. With the aim of enhancing the availability of digital content in offline environments, this article presents a roadmap detailing the practical insights gained from developing a tailored educational encyclopedia called Wikipedia for Schools, available in both English and Arabic. Finally, we offer best practices and lessons learned, including recommendations for future research in this field.

KEYWORDS

offline digital library (ODL), Wikipedia for schools, offline customized encyclopedia, ODL collection

1 INTRODUCTION

When I present Wikipedia to my African colleagues, online or offline, I can't help noticing the dearth of information about Africa. There is more information about the village of Genthod in Switzerland (2,700 inhabitants) than about the city of Thiès in Senegal (260,000 inhabitants). Our notability criteria are heavily biased towards what used to be called the "Global North", and this is flagrant when examining the offline content that I am actively promoting in West African schools. The second-hand printed textbooks that are often used are centered on the French,

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Belgian or Swiss curriculum. My dream is that our online encyclopedia will soon be more inclusive and better reflect the diversity of our world.

—Gabriel Thullen [1]

One of the biggest obstacles to providing a quality education for youth worldwide, especially in rural and remote communities, is the limited availability of high-quality and current educational resources and information. Seemingly quick-fix solutions, such as printing textbooks or providing internet access, are often financially burdensome, infrastructurally unrealistic, or both. Access to a quality education and the digital skills necessary to participate in the information age and global economy greatly impact youth empowerment. This, in turn, leads to increased participation in the labor market and contributes to economic growth [2]. In turn, this contributes to reducing poverty, eliminating hunger, increasing health awareness, and promoting gender equality. Overcoming this inequitable access to educational resources remains a major obstacle for many countries grappling with significant economic challenges that hinder their ability to provide basic infrastructure for schools in urban areas, including electricity and telecommunications, let alone in villages and remote regions. This exacerbates the digital divide, which leads to a widening gap between those who have access to information and those who do not, due to the lack of information and communication technologies (ICTs) and limited accessibility [3].

So, how can we make meaningful access to information a reality in areas that lack the necessary infrastructure and digital skills? One approach has been the offline digital library (ODL). Digital libraries, similar to physical libraries, require meticulous curation to ensure they contain suitable and pertinent resources for the communities they cater to. The quote above illustrates that localization has not always been adequately implemented, despite good intentions. A major challenge is the scarcity of localized digital content, primarily due to the lack of opportunity for people living in offline realities to create digital content that reflects their language, values, culture, and history. This is mainly because they lack the necessary technology and digital skills. Sufficiently representative content will not exist until intentional efforts are made to bring more disconnected people into the digital realm, which may include providing technology and building digital skills. To this end, there are multiple efforts underway among offline digital library initiatives that aim to address the challenges of technology access and digital skill development.

Nonetheless, the curation process of these library initiatives remains a mystery; it has not been adequately discussed in scholarly literature, nor has there been clarity on how the content collections of the most well-known ODLs were created. Accordingly, this article provides a replicable example of how to curate a digital encyclopedia that can be used in various digital settings. The aim is to foster greater representation among ODLs worldwide. In the example detailed here, the digital encyclopedia was curated for the Solar Powered Educational Learning Library (SolarSPELL) Initiative, an organization based at Arizona State University (ASU) that aims to empower learners worldwide through localized, solar-powered, offline digital libraries, combined with relevant skill-building.

This paper outlines the applied work done to create offline digital encyclopedias in English and Arabic for the SolarSPELL ODLs. To provide a roadmap for replicating this process, we will share lessons learned, demonstrate optimal methods and tools, discuss challenges, and reflect on how the process can be improved to include and develop more offline content in additional languages.

2 OFFLINE DIGITAL LIBRARIES

The ODL is an innovative and practical approach to introducing information and communication technologies, as well as providing digital information to rural and remote schools. As such, it can be considered a sustainable, affordable, and effective approach to bringing "a wealth of knowledge without requiring a wealth of investment" [4]. ODLs are generally designed to function as stand-alone technological units that can work even in infrastructure-challenged rural and remote locations. Most projects adopting the ODL model are based on the principle of creating offline Wi-Fi hotspots or standalone wireless servers that replicate an online, internet-like experience. An ODL hotspot broadcasts its content over Wi-Fi and can be accessed by multiple devices with Wi-Fi capability, such as a laptop, tablet, or smartphone, without the need for an internet connection. Although Wi-Fi has become a shorthand way of referring to "the internet" or "being connected," this is technically incorrect. Wi-Fi actually refers to networking protocols that enable wireless communication between devices using radio waves. Thus, any device that utilizes Wi-Fi radio waves (such as a smartphone, tablet, or laptop) can receive a Wi-Fi signal from the library server, connect to this signal, and access the library content stored on the server.

There are numerous projects and initiatives worldwide that have adopted the ODL hotspot model to offer information access in rural and remote schools. Many of these initiatives depend on an offline server to provide local information. Among the most widely-known initiatives are Wider Net's eGranary, Arizona State University's SolarSPELL Initiative, Libraries without Borders' KoomBook, World Possible's RACHEL, OLE's Planet Learning Community Server, as well as Teacher in a Box, School in a Box, and Internet in a Box. Though this is just a partial list (our current tally counts at least 27 such initiatives, but this number is growing), all of these initiatives intersect with the goal of providing offline information to individuals in remote and rural communities who lack adequate infrastructure and have limited or no connectivity.

The ODLs, with their increasing popularity, present an alternative to infrastructure-reliant solutions such as brick-and-mortar libraries. Not only do ODLs have the benefit of portability, with many being small enough to fit in a backpack, but they are also more durable against environmental conditions such as typhoons, humidity, and termites. These conditions can cause damage to physical structures and books, making ODLs a more resilient option. Furthermore, while a physical book at a library can only be in one place at a time, a digital book on an ODL can be downloaded to an unlimited number of devices, making it an appealing solution for resource-constrained schools. Given the growing prevalence of smartphones worldwide, the bring-your-own-device model has proven to be effective, even in low-resource settings where affordable data or coverage may be lacking.

Nearly all of the ODL initiatives mentioned above focus on improving education in rural and low-resource schools. This recognition stems from understanding the crucial role that education can play in enhancing people's quality of life. Indeed, ODLs can provide educational resources, digital curricula, and access to information. By utilizing ODLs, students and teachers can develop digital skills, information literacy skills, and internet-ready skills. These skills have been shown to be essential for meaningful participation in today's information society and are an important step towards digital representation [5, 6].

Yet, the usefulness of digital libraries is not confined to schools. They can be curated to meet any information need, including purposes that are considered important in

developing countries. These purposes include the dissemination of health information, agriculture information, preserving indigenous cultures and languages, and sharing information in local communities [7]. It is arguably the content in the library that is its most important feature. Being able to see oneself reflected in the content of the library can lead to increased interest, engagement, and learning among library users. It also promotes a more accurate understanding of the value of their own history, society, and culture [8].

In other words, representation truly matters. This is why the topic of content curation is extremely important when it comes to offline digital libraries. Yet, despite the number of ODL initiatives, to the best of our knowledge, this article represents the first discussion of the actual curation process for an ODL within the scholarly literature on the topic. As such, it makes a significant contribution to this body of knowledge because the content selected for inclusion in a library is crucial for its use and usefulness. Without discussion, the curation process remains a black box.

3 THE SOLARSPELL INITIATIVE

The SolarSPELL is an offline digital library and information literacy initiative based at ASU. The SolarSPELL Initiative works to empower learners globally by providing access to information and equipping them with the skills to use it effectively. SolarSPELL libraries are specifically designed for use in schools and communities with limited resources. They are ruggedized to withstand extreme environments, compact enough to fit in a backpack, and solar-powered for universal functionality. Since the initiative's launch in 2015, approximately 500 libraries have been established in fourteen countries across the Pacific Islands, South and East Africa, and the Middle East. Most of the library collections currently focus on meeting the information needs of primary and secondary school students and teachers in disadvantaged and remote communities. These communities often lack basic infrastructure such as electricity, an Internet connection, physical libraries, and books.

Partnering with locally-based organizations is a critical component of the SolarSPELL initiative's approach. Localizing the library content, building skills such as information literacy, and conducting monitoring and evaluation activities are all tasks that are carried out in collaboration with local organizations. In all cases where SolarSPELL operates in the education sector, the Ministry or Department of Education is a partner. They provide approval and permission for SolarSPELL to work in schools and collaborate with teachers. Additionally, they often contribute content to be added to the library. Other global partners include the United States Peace Corps and the United Nations Refugee Agency (UNHCR).

The SolarSPELL library's technology functions as a hotspot that transmits an offline Wi-Fi signal. Any device with a browser and Wi-Fi capability can connect to this signal, allowing users to access the library's homepage and all of its content without requiring a password or an internet connection. In terms of hardware, it relies on a Raspberry Pi, which is a minicomputer used as a server to generate the Wi-Fi hotspot. The Raspberry Pi is equipped with a MicroSD card (currently 128GB) that houses the necessary software to operate the system. It also contains the entire library content, which is what the server broadcasts over the offline Wi-Fi hotspot (refer to Figure 1). The rest of the system consists of a solar panel, a lithium-ion rechargeable battery, and a charge controller/voltage regulator [4].

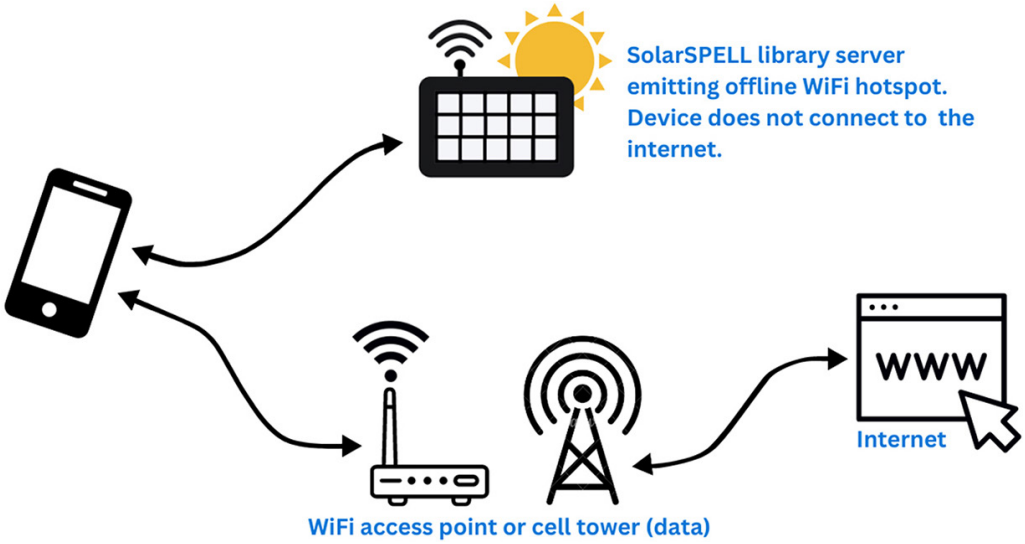

Fig. 1. Comparison of how a device (e.g. cell phone) connects to SolarSPELL library server (offline) versus how a device connects to the Internet (online)

It is worth noting that, compared with similar projects, SolarSPELL is the only one of its kind that integrates solar power into the ODL hardware. On the software side, it runs on the Raspberry Pi's open-source operating system (Raspbian OS), which is loaded onto the micro-SD card. Although the theoretical number of people who can connect simultaneously to the library is much higher, the SolarSPELL team recommends a maximum of 25 library users at a time to ensure optimal speed of access to content for the users, such as video streaming without buffering.

SolarSPELL libraries are localized, meaning the content is specially curated for different locations to account for differences in language, customs, traditions, curriculum, and laws of each country in which it is implemented [5]. This means that there is a continuous need to create and adapt content whenever the initiative expands into new geographic locations or where different languages are spoken. Furthermore, many studies have indicated the need to develop digital skills for both teachers and students in order to ensure the effective utilization of digital initiatives in schools [9, 10, 11, 12]. Thus, by providing appropriate localized content and training teachers, and then having them teach their students how to use SolarSPELL's hotspot and its ODL, the SolarSPELL team has demonstrated that the initiative's approach has the potential to enhance students' information literacy skills in offline environments [13]. In the following sections, we will illustrate the curation process that the SolarSPELL Initiative developed to create an offline Wikipedia for Schools.

4 WIKIPEDIA

Wikipedia is a collaborative, multilingual, web-based free-content encyclopedia operated by the Wikimedia Foundation, a non-profit organization. The foundation's mission is "to empower and engage people around the world to collect and develop educational content under a free license or in the public domain and to disseminate it effectively and globally" [14]. Since its launch on January 15, 2001 [15], Wikipedia has become the largest multilingual encyclopedia in the world and one of the most well-known and visited websites. Millions of users rely on it daily to find the information they need [16]. According to the site's statistics, Wikipedia contains over

59 million articles in more than 300 languages. The English Wikipedia alone has 6,533,696 articles and received a total of 120 billion page views in 2021 [17].

Wikipedia articles, known as encyclopedia entries or web pages of content, are written collaboratively by volunteers from around the world. Regarding copyrights, licenses, and ownership, the Wikimedia Foundation does not own any copyright over the text or illustrations of the Wikipedia articles. This is because most of Wikipedia's content is co-licensed under the Creative Commons Attribution-Share Alike 3.0 Unported License (CC BY-SA) and the GNU Free Documentation License (GFDL) [18].

From an educational perspective, students around the world who have an internet connection rely on Wikipedia to understand lessons, conduct academic research, and find links to reliable sources [19]. The ease of accessibility and high ranking in search engine results make Wikipedia popular among students. It is often the first and best option for many when searching for information. Nonetheless, as a user-generated resource, there are disagreements about the reliability of Wikipedia. Wikipedia itself encourages its readers to employ critical thinking, verify sources, and include a disclaimer stating that they cannot be held responsible for any errors. Wikipedia also points out that nearly all (if not all) other trusted sources of information, such as encyclopedias, dictionaries, and esteemed news outlets, publish similar disclaimers.

Still, concerns remain about the reliability of Wikipedia's content, primarily due to the varying levels of critical thinking skills and differing abilities to evaluate the quality of information among its users [20]. To address this, teachers in many countries are shifting from forbidding and excluding Wikipedia as a resource to utilizing it as a starting point for students' assignments, research, or to develop critical thinking and information literacy skills [21, 22, 23, 24]. Teaching students how to read and use Wikipedia critically can enable them to evaluate the content of its articles and assess their credibility, which is an essential component of developing information literacy skills [20, 25]. Some teachers are actively engaging their students to create new content on Wikipedia and address the acknowledged lack of representation of historically underrepresented groups within Wikipedia's content [22, 26]. The Wikimedia Foundation, the parent organization of Wikipedia, deserves credit for actively encouraging and promoting efforts to address the issue of underrepresentation among its contributors.

A growing number of scholars argue that negative perceptions of Wikipedia are outdated. They point to the Wikimedia Foundation's overall transparency, particularly in terms of its policies for review and editing. The foundation also acknowledges and takes steps to address its own shortcomings in terms of reliability and representation [27, 28, 29]. These scholars further posit that Wikipedia has become the ultimate repository of reliable information in an era of disinformation and amidst historically high levels of distrust in media and other institutions [27, 28, 29].

While the authors of this article would like to believe that progress has been made in terms of content reliability, both reliability and representation can only truly occur once there is a critical mass of culturally and linguistically representative Wikipedia editors. Such a level of representation has not yet been achieved.

To clarify, all of the activities described above, which aim to promote information literacy and enhance representation on Wikipedia, are carried out online. According to estimates from the International Telecommunication Union (ITU), approximately one-third of the world's population has never accessed the internet, and about half of the global population is unable to effectively utilize the internet due to various factors such as limited availability, high costs, a lack of content in their native language,

and insufficient skills like literacy and information literacy [30]. Thus, the claim that Wikipedia is "the sum of all human knowledge" [31] is an overreach, considering that at least half of the world's population has not been able to access, learn from, or contribute to this repository of knowledge. This article attempts to address the aforementioned critique with a call to action.

While it is possible to obtain a complete offline version of Wikipedia in a compressed file, it is not desirable to include a full version in an offline digital library due to several considerations. These include the large file size, which may require more storage space than an offline library can provide. Additionally, a significant percentage of Wikipedia's content may not be relevant or age-appropriate for a specific educational setting. Such considerations are increasingly critical in educational projects that target rural and remote areas, where prior exposure to information is more limited. This limited exposure makes these areas more susceptible to information overload [5]. Thus, the importance of a curated library (and more specifically, a curated encyclopedia within that library) that is relevant to a specific cultural, linguistic, and educational context is paramount.

5 WIKIPEDIA FOR SCHOOLS

The initial version of Wikipedia for Schools (WFS) was created by SOS Children's Villages UK, an international non-governmental organization (NGO). SOS initiated the curation process in 2005 and launched the initial version in 2006. According to the staff involved in creating the first version, all articles were hand-selected by staff and volunteers of SOS Children's Villages. These articles were chosen based on specified parameters and were designed for individuals following the UK national curriculum and programs that are based on the UK curriculum worldwide. After initially facing resistance from the Wikimedia Foundation, SOS eventually obtained permission when one of Wikimedia's co-founders became aware of their work and advocated on their behalf. Between 2006 and 2013, SOS Children's Villages released multiple updated versions of WFS. However, they stopped providing updates after 2013 due to a lack of funds.

The SOS version of WFS continued to be used in several offline digital education projects well beyond its 2013 update, but it became increasingly outdated. Over time, the number of requests from SolarSPELL library users for an updated version of WFS increased. SolarSPELL staff reached out to SOS and the Wikimedia Foundation to inquire about their plans for an updated version. Upon learning that such plans did not exist, SolarSPELL obtained permission from both parties to build upon SOS' work and create a new version of WFS. SolarSPELL connected with their contacts at Kiwix, a nonprofit software company that compresses and hosts websites. These websites can be downloaded for offline use, allowing people with no or limited internet access to access them. Kiwix has agreed to host all future versions of WFS by SolarSPELL. These versions will be made available for free download to anyone with an internet connection, allowing for offline use in the future. Furthermore, Kiwix has committed to automatically updating WFS every six months using software that retrieves the latest version of each article from the live Wikipedia articles.

Accordingly, the SolarSPELL faculty and staff initiated an effort to develop a new version of WFS, which involved the participation of numerous students from ASU. The following section explains the process of creating a new offline-customized version of WFS by ASU-SolarSPELL.

5.1 Creating a new version of Wikipedia for schools

Launching the challenging endeavor of developing a new edition of WFS, Dr. Laura Hosman, co-founder and co-director of SolarSPELL, guided multiple teams of graduate students throughout five semesters (Summer 2020, Fall 2020, Spring 2021, Summer 2021, and Summer 2022) in an online, project-based course. In addition to updating the content of WFS, one major goal of the SolarSPELL initiative in relaunching WFS was to ensure that the content was more inclusive and representative of library users worldwide. This means moving away from its Eurocentrism and decolonizing the content. As the course was offered online within the Global Technology and Development graduate program at ASU, each cohort of students who chose to take the elective course was globally diverse by any standard for a US-based university course. Out of the 28 students who took the course, 21 had a strong international perspective, with students from 17 different countries represented. The students were either originally from, currently living in, or had spent significant time in Bosnia-Herzegovina, Croatia, Egypt, Guatemala, Guyana, India, Jordan, Kazakhstan, Korea, Lebanon, Malaysia, Mexico, Moldova, Peru, Syria, the US, and Yemen.

In the first semester, the students were presented not only with the challenge of developing a new and more inclusive version of WFS but also with creating a plan of action, or roadmap that could guide future students' work. It was evident that the completion of version 1 of WFS, which would require the creation of an entirely new WFS, would require more than one semester's effort. Ultimately, the students identified as necessary the completion of all of the following tasks:

- Determine the documentation procedure and thoroughly document all work for institutional knowledge.
- Define criteria for selecting articles to be included, considering factors such as quality, appropriateness, and relevance.
- Self-organize into small groups to meet regularly and carry out work.
- Determine the categories and subcategories to be used.
- Determine which categories, sub-categories, and articles from the previous version should be kept.
- Determine which subjects are missing and which articles should be added.
- Search for new articles to update all categories and sub-categories.
- Clean up the documentation to ensure that future student teams can continue the process of reviewing, updating, and improving WFS. (Documentation appears at the beginning and the end. It should be ongoing, but our experience has shown that documentation work tends to be neglected during a longer-term project and often requires clean-up towards the end or after the project is completed.)

Curating WFS from the vast selection of articles was an arduous and time-intensive process. Once the articles were selected, there was still much work to be done. The articles then needed to be reviewed to ensure that the content was age-appropriate and/or culturally-appropriate, that the article was indeed about the specified topic, and that it was complete enough to be included.

After four semesters of continuous work, version 1 (in English) was ready. A year after completing Version 1, a fifth semester (Summer 2022) was dedicated to making improvements, resulting in the creation of Version 1.2. In total, we estimate that creating these versions of WFS took over 4,500 hours of work, contributed by more than 30 individuals, including students, faculty, and SolarSPELL staff.

A list of 9,469 new and updated articles was prepared and later submitted to Kiwix. Kiwix used their software to assemble the new version of WFS based on this list of articles. The size of this new version of WFS is 235.2 MB. Kiwix made this new version available to the public on its website in August 2021. Kiwix reports that there are 40 million downloads annually across all versions of Wikipedia hosted on their site. The SolarSPELL initiative has also provided this new English-language version of WFS in the locations where it has introduced new versions of its ODLs. At the time of writing, these locations include the Marshall Islands, Ethiopia, South Sudan, Lesotho, and Malawi.

5.2 Creating the SolarSPELL Middle East library

With the expanding scope of the SolarSPELL initiative to areas where English is not the main language of instruction in schools, the SolarSPELL team has been actively engaged in developing new offline digital libraries in other languages. In 2021, the team embarked on developing a library primarily in Arabic and Kurdish, known as the SolarSPELL Middle East library. They are working collaboratively with a locally-based partner in the autonomous region of North and East Syria. This section provides a brief discussion of the process of creating, compiling, and categorizing the offline library collection in Arabic. Next, a detailed discussion will be conducted about the processes undertaken to create an offline customized encyclopedia—the Arabic version of Wikipedia for Schools—that will be included in the SolarSPELL Middle East library.

Curating work on the Middle East Library collection began in the fall semester of 2021. Two Arabic-speaking graduate students, both of whom had been part of the first cohort of students working on creating the English-language WFS, conducted a search for Open Access (OA) and Open Educational Resources (OER) content in Arabic across the web. Google Drive was used to collect, upload, and categorize each piece of content with the help of some of the platform's tools, such as Google Forms and Google Spreadsheets.

The following semester, Spring 2022, the SolarSPELL team recruited seven additional native Arabic-speaking students to begin the process of curating the content that had been identified in the previous semester. Much of the time and effort was spent curating the resources and on meta-data tagging. Meta-data tagging is the process of identifying and labeling characteristics of the resource, such as keywords, title, and author that make it possible for the library's thousands of resources to be searchable and discoverable. Meta-data tagging also enables the hyper-linking of similar resources through shared keywords.

In terms of the overall workload involved in creating a library, SolarSPELL's full-time staff members contribute to the process in various ways. They manage student teams, coordinate tasks and resources, communicate expectations and timelines, ensure accountability and follow-through, make strategic decisions, advise on technologies, oversee technical and software aspects, and manage library content. It typically takes about two years and approximately 14,600 person-hours for the SolarSPELL team, with the involvement and assistance of students, to curate a brand-new library. The creation of libraries occurs simultaneously with SolarSPELL's operational tasks, which include forming and developing local partnerships, fund-raising, recruiting and overseeing all of the hundreds of students' contributions to the initiative, developing and testing the software and hardware that make up the SolarSPELL library, and many other activities.

The SolarSPELL Middle East library collection, at the time of writing this article, consists of 15 main categories. Each category contains several sections, and each section contains a set of files in multiple formats that can be browsed or downloaded. The total number of resources contained in the whole Middle East library collection is 15,000, of which 13,000 are in Arabic, with a total size of approximately 55 GB. At the request of our partners in NE Syria, the library's interface (homepage) was made multilingual to include Arabic, Kurdish, and Syriac, as those are the languages spoken in the region. The SolarSPELL Middle East library is the collection for which the Arabic WFS was created. In the following section, we will provide a detailed explanation of how to create the Arabic WFS. This will serve as a helpful guide for individuals who aspire to become WFS creators.

5.3 Creating the Arabic Wikipedia for Schools

To create an offline, customized encyclopedia based on Wikipedia (specifically, Wikipedia for Schools in Arabic), the following essential steps are detailed below:

1. Select suitable articles.
2. Document all work, including decisions made and the reasoning behind them, challenges encountered, and how to address them, so that future teams or individuals can undertake the task of revising and improving the work in the future. Documentation should be an ongoing process.
3. Prepare and create a customized encyclopedia.
   - Create a homepage and its sub-pages on the wiki to welcome users.
   - Prepare the final list of article titles in Kiwix/wikitext formats.
   - Create a customized encyclopedia in a ZIM file.
4. Review the final ZIM file and share it or embed it in the target projects or libraries.
5. Ensure that all work has been properly documented for future reference.

Many of these steps are time-consuming and require significant effort, technical expertise, and a good understanding of Wikipedia, as explained in the subsequent paragraphs. This paper seeks to provide a clear guide on how to create an offline-customized encyclopedia in any language, using Wikipedia as a base.

Selecting suitable articles. This process, referred to as "localization" by the SolarSPELL team, is an important step in ensuring a positive reception and ongoing use of the digital encyclopedia and the digital library as a whole. In this case, considerations included the nature of the local curriculum, the cultural and traditional diversity of residents in NE Syria (and the Arab world as a whole), and its suitability for children in particular.

The first step was to browse the Arabic Wikipedia, selecting wiki articles based on their titles, and then choosing the appropriate articles that were relevant to the local context. As articles were selected, they were classified according to the categories found in the larger offline library, including mathematics, history, science, and others. However, it became apparent that browsing and selecting articles from the Arabic Wikipedia was immensely time-consuming. To expedite the process, the author adopted a new strategy that utilized the final titles from the English Wikipedia for Schools, which comprised 9,648 articles, as a reference for matching with the Arabic version. Instead of searching for articles on the Arabic Wikipedia and evaluating their relevance, the task shifted to matching the English articles with their Arabic equivalents and evaluating them simultaneously. Accompanying the

evaluation with the matching process is essential in the selection process as it saves time and effort. In addition, this strategy provided an opportunity to reevaluate the content of the original list of articles to assess their suitability for the English or Arabic WFS. This ensured that the articles were in line with the primary objective of the SolarSPELL project, which is to provide relevant and appropriate localized content.

While the matching strategy improved efficiency compared to the browsing and selecting strategy, it was still a laborious process. Matching the English article to its equivalent article in other languages, such as Arabic, can typically be accomplished through the "Languages" section in the sidebar of each Wikipedia article. This feature is known as Wikipedia's inter-language links. These inter-language links, which can be found on the left sidebar, connect corresponding articles in other languages (see Figure 2). Searching for more than 9,400 article titles and manually visiting each one to find its Arabic equivalent, then reviewing and evaluating the content for appropriateness and relevance, and maintaining a list of selected articles, is a complex and challenging task. Therefore, it was necessary to search for a solution to automate some or all of these steps.

Fig. 2. A Preview of a Wikipedia article along with Wikipedia languages section

A wide range of software, applications, tools, and add-ons were tested to discover a more efficient and quicker method to (a) retrieve the link to an article's equivalent in another language; (b) indicate the absence of an equivalent article in the requested language; and (c) expedite the manual review and evaluation process for each article simultaneously. A Google spreadsheet was used as the primary workspace for matching, translating, collecting, linking, sorting, and evaluating each article title individually. Various Google spreadsheet functions and add-ons were also utilized. Likewise, a Firefox browser add-on called Link Preview Sidebar was used to expedite the process of opening a new Wikipedia URL. This add-on allowed the user to open the URL in a new "side" tab within the same tab that was being used to browse the spreadsheet, instead of opening a completely new tab. Then, the staff of the Wikimedia Foundation shared some open-source tools that we tested. After conducting numerous experiments, a combination of these tools and functions was adopted to streamline the matching process. This approach can be adopted and modified by anyone with a working knowledge of Wikipedia, and Google Spreadsheets, or Excel. Table 1 provides an overview of the tools and functions that were utilized.

Table 1. Tools and functions used to accelerate manual review of articles

Software/Tool	Add-on/Function	How Does it Work?	Rating of Results
Google Sheets	=GOOGLETRANSLATE(*,"en","ar")	Translate the English titles to Arabic	Ineffective
Google Sheets	=HYPERLINK("https://en.wikipedia.org/wiki/"&*)	Converting (Input) English titles to Eng – Wikipedia URLs	As intended
Google Sheets	=HYPERLINK("https://ar.wikipedia.org/wiki/"&*)	Converting (Output) Arabic titles to Arabic – Wikipedia URLs	As intended
Google Sheets	="en:"&*	Combining article title with the English language code according to ISO 639-1 e.g., "en:IBM"	As intended
Wikipedia and Wikidata Tools – a Google Sheets Add-on	=WIKITRANSLATE(*,"ar","0")	Returns Wikipedia translations (language links) for a Wikipedia article. Used to recall the translation of article titles in bulk while retaining the original English titles that do not have equivalent titles in Arabic.	Usable, but indirectly. Still a critical tool.
Google Sheets	Find and replace option	Finding the space in the titles consisting of more than one word, to convert it into a wiki markup: e.g. putting an underscore between each word, for example, the Great Pyramid	As intended
Link preview Sidebar (Firefox Browser Add-on)	There are two ways to open a link in the sidebar: (1) Right click on a link and select "Open in the sidebar," (2) Hold the Alt key while clicking on a link (Command key on Mac)	To speed up opening a new Wikipedia URL in a new "side" tab within the same tab used to browse the spreadsheet instead of opening a new tab	As intended
Other tools shared by Wikimedia Staff: PetScan		A versatile query tool that can filter Wikipedia articles based on a variety of criteria, including language.	Not used at this stage, but could be used later to create offline-customized encyclopedia in other languages once finalized list of articles exists

Note: (*) Cell name in the spreadsheet.

Prepare and create the customized encyclopedia. This step consists of three stages. First, the homepage/welcome page for WFS is prepared. Then, the list of article titles is finalized. Finally, the compressed ZIM file is created. All of these stages are interconnected and collectively constitute components of the offline-customized encyclopedia that will be created. Each stage is prepared following Kiwix's instructions (described below) to create a ZIM file that contains a customized encyclopedia. This file allows users to browse the content offline.

Kiwix is a nonprofit organization that curates and distributes offline content from various sources, including Wikipedia, TED Talks, and Project Gutenberg. Users can freely download any of these sources for offline use. Kiwix uses and provides open-source software that functions as an offline web browser and reader. It primarily relies on the creation of ZIM-compressed files. A ZIM file is a highly compressed open-source format that stores and compiles the contents of a wiki (or another website) for offline use. The open ZIM project aims to "make web content available offline" [32]. It is maintained by Kiwix and supported by the Wikimedia Foundation [33]. The ZIM format offers several powerful and essential features. One of its most notable features is its full-text search capability. Additionally, it has a small file size, comprehensive indexing, a built-in image handler, and the ability to read the entire file from different devices (such as mobile, tablet, laptop, computer,

and Wi-Fi hotspot) without the need for decompression. This can be done using an offline reader program such as Kiwix Reader [34]. In the same context, to prepare for the aforementioned stages, Kiwix explains that projects interested in offline content can request the assistance of the Kiwix team in creating a ZIM file. This can be done by preparing and providing a homepage (Figure 3), a text file with article titles in the correct format (described below), as well as a project title, description, and logo.

It is worth noting that one of the authors of the paper has been a member of the Arabic Wikipedia and its community of creators, translators, and editors since 2008, and they have a user account with editing and retrieval permissions. This proved to be essential in completing the Arabic version of WFS. At least 18 additional articles were identified as important enough to be translated into Arabic and added to Wikipedia before the Arabic WFS was created. As such, we recommend having a Wikipedia editor on the team or ensuring that someone obtains the necessary credentials in the early stages of the project. This person will ideally coordinate with Wikipedia administrators during the WFS creation process.

Fig. 3. A screenshot of the Arabic homepage of Wikipedia for Schools located on Arabic Wikipedia
Note: The Arabic WFS can be visited at (https://w.wiki/5X8E).

In the second stage, the final list of article titles is prepared and formatted. The final list file must comply with Kiwix's instructions, with one article title per line and underscores instead of spaces. Table 2 shows examples of properly formatted article titles from the English-language list. The final list file should be exported in either .XLS, .XLSX, or .CSV format, with preference given to the latter. It should then be shared with the Kiwix team to create the ZIM file by submitting a request [34].

ZIM file requests are given by creating a "ticket" in the "Zimfarm" sub-repository, which is part of the OpenZIM repository on GitHub. The repository is available at https://github.com/openzim/zim-requests/issues/new/choose. When submitting a request to create a ZIM file, all project information must be provided as follows: the URL link of the desired wiki (e.g., https://ar.wikipedia.org/), the URL link to the welcome homepage created in the desired wiki, as well as the file title, description, license, language, and icon. The final file containing the list of article titles must be attached to the same GitHub ticket page where the request is being submitted.

Table 2. Sample of Wikipedia article titles from the English-language list

English Articles (Kiwix Format)
Wikipedia:Wikipedia_for_Schools/Welcome
Metre–tonne–second_system_of_units
Joseph-Louis_Lagrange
Kepler's_laws_of_planetary_motion
Limit_(mathematics)
Limit_of_a_function
Line_(geometry)
Linear_algebra

After submitting the request, the customized ZIM file should be available within a few days. Subsequently, the final file will be hosted and published on Zimfarm's platform, which is maintained by Kiwix. This will make the file accessible for download and use by anyone, anywhere, thereby promoting the principles of open access. Hence, the completion of the third and final stage of creating an offline-customized encyclopedia.

It is worth noting that it is possible to create a ZIM file without relying on a third-party tool such as Kiwix. However, Kiwix has advantages in terms of technical expertise, cooperation, and providing support when needed. This article seeks to guide non-technical users on how to create a customized version of Wikipedia, specifically based on the steps taken to create the WFS version. Otherwise, from a purely technical perspective, there are numerous tools and solutions available for the third stage of creating custom ZIM files.

Final results. Work on the Arabic WFS began in early January 2022. The final list of article titles was delivered on April 30, 2022. After that, version 1 of the Arabic WfS was launched and trialed. It was subsequently included in the SolarSPELL Middle East Offline Digital Library by mid-June 2022. By utilizing the workspace provided by Google Sheets, we were able to compare and assess each article in the sample list "Wikipedia for Schools in English." The results of this evaluation are as follows: The original list contained 9,469 titles. Out of these, 411 titles were classified as "error", 222 titles as "undefined", and 2,996 titles as "not found" in Arabic. However, we were able to correct 155 of these titles. While the number of Arabic titles that matched reached 6,220, there were 189 duplicate titles and 15 titles that were considered to have age- or culturally inappropriate content. This brought the total number of matching Arabic titles to 6,016. Later, 555 additional articles were selected and added from the Arabic Wikipedia's "Featured" and "Good" categories, as determined by the community of editors. This brought the final number of articles in the Arabic WFS to 6,571.

The ZIM file for the Arabic version of WFS can be accessed by visiting the Zimfarm platform at https://farm.openzim.org/recipes/wikipedia_for_schools_ar. An online version of the English-language WFS can also be accessed by visiting the Kiwix Library (https://library.kiwix.org).

The offline Wikipedia for Schools in Arabic (Version 1.0) is included in the SolarSPELL Middle East ODL (Figure 4). Users can browse its articles either through the categories on the homepage or by performing a search in the search box at the top of each Wikipedia article. Further assessment is required to gather feedback from students, educators, and stakeholders regarding the content, classification, and presentation of the encyclopedia, as well as to identify and address any errors that

may occur during its use. Moreover, an encyclopedia, similar to a library, is never complete. Therefore, the Arabic version of WFS will undergo revisions and improvements in the future. These changes will be based on feedback from our library users, just like with all SolarSPELL library collections.

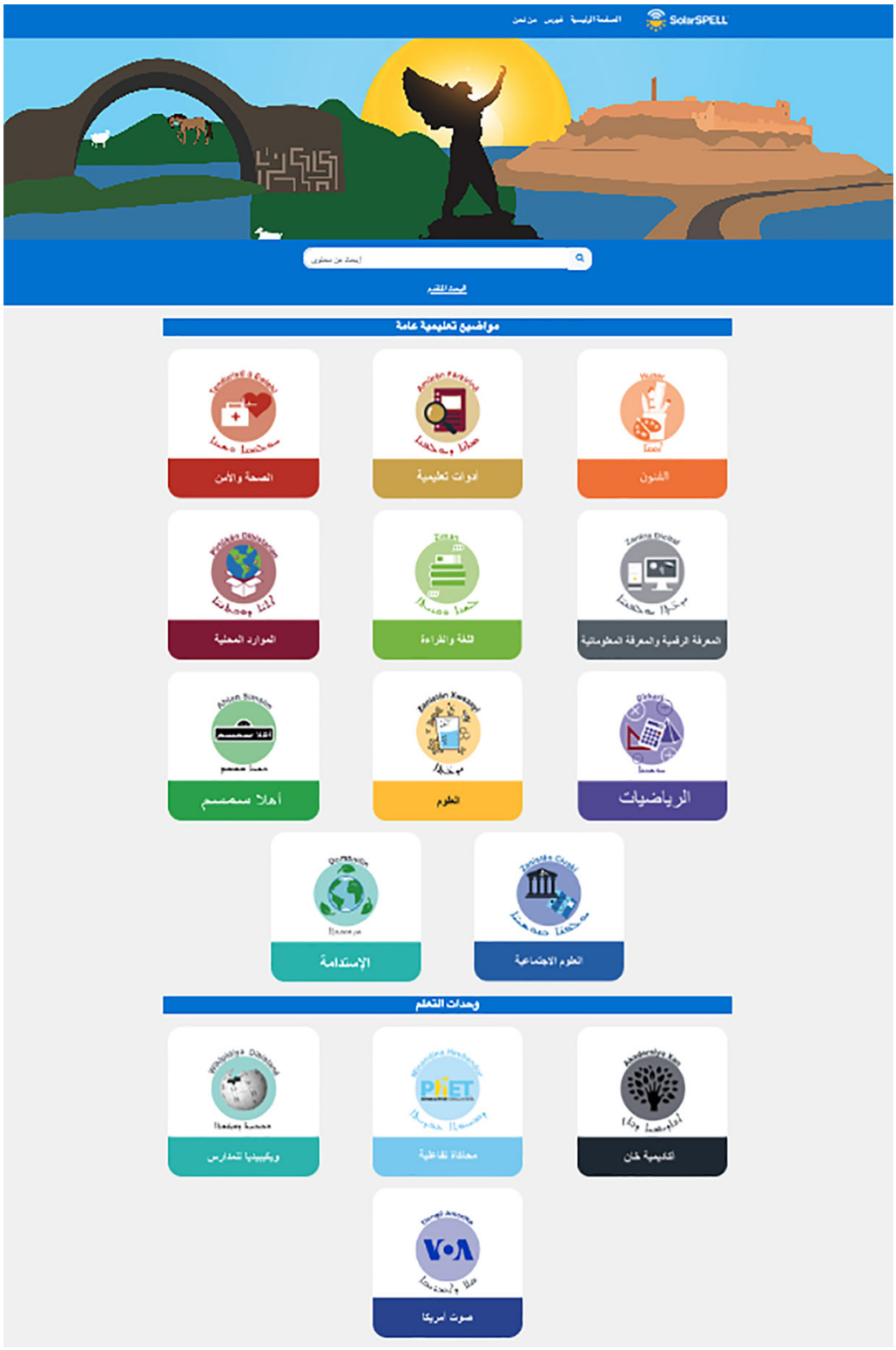

Fig. 4. The homepage of SolarSPELL's Middle East offline digital library

6 BEST PRACTICES AND LESSONS LEARNT

Throughout the multi-year process of updating the English WFS and creating the first-ever Arabic version, we learned many lessons through trial and error that guided us in formulating best practices. We are sharing these best practices and lessons learned with the intention of promoting open access and facilitating efficient replication in the future.

6.1 Article selection

- **Leading a curation team:** When forming teams (in the case of SolarSPELL, student teams) to work on curating WFS articles, we have identified some best practices.
  - To establish clear criteria in the selection of content (or articles) to serve as a guide for the students or volunteers doing the curation.
  - To conduct training for participating students and volunteers on the inner workings of Wikipedia, what constitutes a high-quality article, how to identify school-appropriate content, processes for localization, and research skills.
  - To engage individuals who are familiar with the cultural and linguistic context of library users.
  - To establish and communicate clear expectations, goals, and timelines.
  - To equip teams with project management tools to track progress and hold each other accountable.
  - To schedule frequent check-ins among the sub-teams, the full team, and project leaders.
  - Thoroughly document all work so that future teams or individuals can pick up where another team left off.
- **Curate relevant and localized content:** When the SolarSPELL team received the original version of WFS, they noticed a bias towards British content. During the curation of the new English-language WFS, the SolarSPELL team made a deliberate effort to remove the euro-centric bias and decolonize the content. While progress was made in that area, there remains a significant opportunity to continue this shift and better reflect the Global South in WFS content. A significant contributing factor to this issue is that Wikipedia editor communities mainly consist of skilled internet users, with the majority being from the Global North, as the introductory quote to this article attests. Using local curriculum to guide article selection can help reduce bias; however, there may still be a lack of information regarding certain local topics. Increased involvement from all regions and cultures, which the Wikimedia Foundation is actively promoting, could enhance representation.
- **Plan for human error:** Both the curation of articles for WFS and the creation of the original articles on Wikipedia are carried out by fallible individuals, which necessitates a focus on continuous improvement. The SolarSPELL team's initial review of the original WFS revealed several errors, such as duplicate and blank articles, mislabeled titles, misspellings, and incorrect formatting. Corrections were made, and surely some new errors were introduced. We recommend planning for progress, not perfection.

6.2 Wikipedia for schools creation and beyond

- **Become a Wikipedia editor:** When creating the WFS main homepage and its sub-pages on Wikipedia, it is highly recommended to follow these steps.
  - To edit on Wikipedia, create an account and refrain from anonymous editing.
  - Before starting to create or edit any Wikipedia pages, it is important to communicate with one or more Wikipedia administrators in the language in which the work will be carried out. This is necessary in order to inform them and the community about the intended actions. Doing so would also make it easier and faster for the community and its administrators to provide assistance and support whenever possible.
- **Participate in the community of practice:** Wikipedia has fostered a community of practice based on the principles of open knowledge and mutual benefit. Within this community, it is always welcome to provide assistance, necessary training, or advice, whether the community members are expert editors, administrators, or even employees of the Wikimedia Foundation itself. We recommend actively participating in this community of practice throughout the curation process, both to give and receive assistance.
- **Advocate for open content:** The sole reason this work is possible is because of open-access content. To disseminate information to a wider audience worldwide, it is important to promote and support the creation and production of open content and open educational resources (OER).

6.3 Directions for future work

In addition to the opportunities for expanding and continuously improving WFS, there are numerous potential avenues for future work in this field. Now that WFS is becoming more widely available for teachers and students around the globe through the SolarSPELL library and other ODL platforms, it is important to conduct a study to demonstrate the extent to which students and teachers benefit from having access to WFS. Providing access to information is merely the first step; the next step is researching the long-term outcomes for students and teachers.

With the tools available at the time of completing this work, the process of creating WFS in English and Arabic was highly manual. If this work is to be continued and duplicated in other languages, it warrants an exploration of how new technologies, such as artificial intelligence (AI), can improve efficiency and accuracy. One example is automating the evaluation for quality and age-appropriateness. Many more questions arise on how—or if—AI can help curate WFS. Could AI overcome some of the more deeply ingrained biases in the process? Could it be used to find more locally relevant content by cross-referencing it with the national curricula of countries around the globe? Could it help reduce underrepresentation? Could it be used to assist in the translation of articles into multiple languages? These are just a few of the possibilities, with many new ones emerging as AI technology advances.

7 CONCLUSION

Collecting, evaluating, and organizing the contents of an offline digital library is a monumental undertaking and inevitably consumes a significant amount of time

and effort. While many organizations are undertaking this effort, there is little publicly available information documenting this process. This significant disparity in addressing and discussing such a crucial process provides compelling evidence for the complexity and challenges involved in curating and creating ODLs. Similarly, the absence of standards, guidelines, or policies regarding digital library curation has resulted in libraries that vary greatly in terms of their breadth, depth, and usefulness for users. This article represents the first step in addressing this shortcoming.

Ultimately, this paper aims to shed light on the processes and best practices for creating an offline-customized Wikipedia. It also aims to clarify the steps and tools that can be useful in this endeavor. Further, we set out to document the process of creating the first-ever version of WFS in a language other than English. The results and lessons learned from this work emphasize the importance of accessible, localized, representative offline content in reaching resource-constrained communities with appropriate, safe, and meaningful educational information. The ultimate hope is that this article can serve as a guide for expanding and replicating customizable digital encyclopedias for learners worldwide, regardless of whether they are used online or offline. This can be done without requiring advanced technical or specialized knowledge.

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