Bridging the Digital Divide by Implementing an Online and Offline Technology-Based Learning Management and Assessment System: Cross-Curricular Skills Development through Feedback and Accountability

Evamaria Brigitta Kaiser

Wüerleweg 37

FL-9491 Ruggell

+41 78 204 54 24

evamaria.kaiser@hotmail.com

Research Proposal

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First Supervisor: Prof. Dr. Benő Csapó

Second Supervisor: Prof. Dr. Ingo Barkow

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Abstract

While there is large-scale research conducted with ever expanding online tools and software with regards to technology-based learning and assessment that addresses higher order thinking skills, making the same tools and software available offline is still a challenge and under-explored research area. If available offline, it is a powerful means to close the digital divide, which is a growing challenge. The ultimate goal of literacy development for communication, learning, and participation to foster equity implies enabling the roughly half of the world's population that does not have access to the internet to join the connected global population. Considering recent findings across educational sciences, data is vital to plan structural measures in policymaking, teaching, learning, and TBA for which the development of tasks that stimulate cognitive development is vital. This research proposal aims to establish the groundwork for digital offline learning and assessment by the means of the latest software innovation with ongoing research to bridge the digital divide. Whereas other digital offline software holds one single programme, this software can hold multiple programmes. Programmes that so far are simply available online can be made available offline and accessible to various devices like how online programmes are accessed, within the allocated range. To enhance 21st century learning with a focus on problem-solving skills in remote areasas well, background research questions, as well as the research design and project plan will be presented to write a cumulative thesis for this Ph.D. by publication. The findings will be presented not only in scholarly settings such as conferences, but also to policymakers and educators in order to equip learners with 21st century learning skills.

1 Introduction

The past two years have changed how education is organized in multiple countries and schools. The pandemic and the war have especially pushed much teaching and learning online. Thousands of people are forced to live in unstable conditions where internet connectivity is poor. This draws attention to an estimated fifty percent of the world population that does not have access to the internet, for which figures vary due to the lack of data (Alliance for Affordable Internet, 2022; International Telecommunication Union, 2022). Considering lockdowns, quarantine, mass migration, and other consequences, massive disruptions to schooling occur. Despite curricula that promote 21st century learning in a skill-oriented manner, especially time off school while still learning, is showing where and at which levels approaches to learning are being rethought (Colao et al, 2020; Zhao, 2020). Subsequently, the lack of equitable access to education makes the digital divide more evident than ever (Brown, 2020). Despite national policies supporting curricula by regulating technical and logistic resource allocation, many educational institutions and districts are still to catch up with the age requirements to live up to (inter)national standards (Li et al., 2021). Equipping children and adolescents with the lifelong learning skills required to cope in the digital culture and age, independent of time, location or special needs also comes with its challenges in motivational aspects (Dhawan, 2020).

There are various schools of thought when it comes to learning. One considerable area with still immense potential in the 21st century is digitally mediated, authentic learning contexts (Walker and White, 2013; Kessler 2018). Considering that the speed at which information can be transmitted through digital technologies has increased significantly (Walker and White, 2013), also the skillset of how to operate the same gains value.

(Ollivier, 2017) is required to engage in the digital culture (Kormos and Kiddle, 2013; Cambourne and Kiggins; 2013). To emphasize the benefits for future skills acquisition through authentic digital artifacts, human interaction-supportive technologies that foster collaborative networking through information curation, communication across time and country borders as well as across formal and informal contexts with meaning-making activities are needed (Rogoff et al, 2016; Walker and White, 2013; Ollivier 2018).
Consequently, communicative competencies are key to learning success, as the Council of Europe (no date) emphasizes. This also shows the need for accounting for the relevance of assistive technologies in learning and assessment, fostering intercultural and cross-curricular skills.

This research proposal argues for the significance of considering the digital divide in the development of learning and assessment in areas where there is no or poor internet access. Since the technology facilitates online programmes to be made available offline. The current research going on with the means of the digital library 1, this comparative study proposal contributes to designing a dynamic and hybrid learning and working environment based on a successful learning model which has been researched for six years by Palani et al. (2021), the foundation of the current research on digital skills development with the means of a digital library.

1 Background information DigiNet and digital library: https://juxtaguide.com/public/files/pdf-145.pdf

The latter combined with a digital portfolio similar to Seesaw (2022) provide the opportunity to introduce the latest educational technology innovations to be combined in a school and learning management system. Still, it holds the potential to build in formative TBA where cross-curricular skills assessment is key. This combination allows personalized learning and assessment even in the remotest areas when working with the currently tested technology that can make online programmes available offline. Many learning management systems only run with internet connectivity. The data thus gathered does not include those who are deprived of the internet so there is an urgent need to develop a system where existing LMS software can also run on servers that work offline. Thereby, providing equal opportunities to learners even if they are not connected to the internet.

2 Background

2.1 Standards and curricular aims to foster future skills

Future skills in 21st century learning include interdisciplinary approaches to learning. Therefore, networking, autonomy within the community as well as multiliteracies play important roles (Ollivier, 2019). The international society for technology in education (ISTE, 2022) provides standards for students, educators, coaches, and leaders.
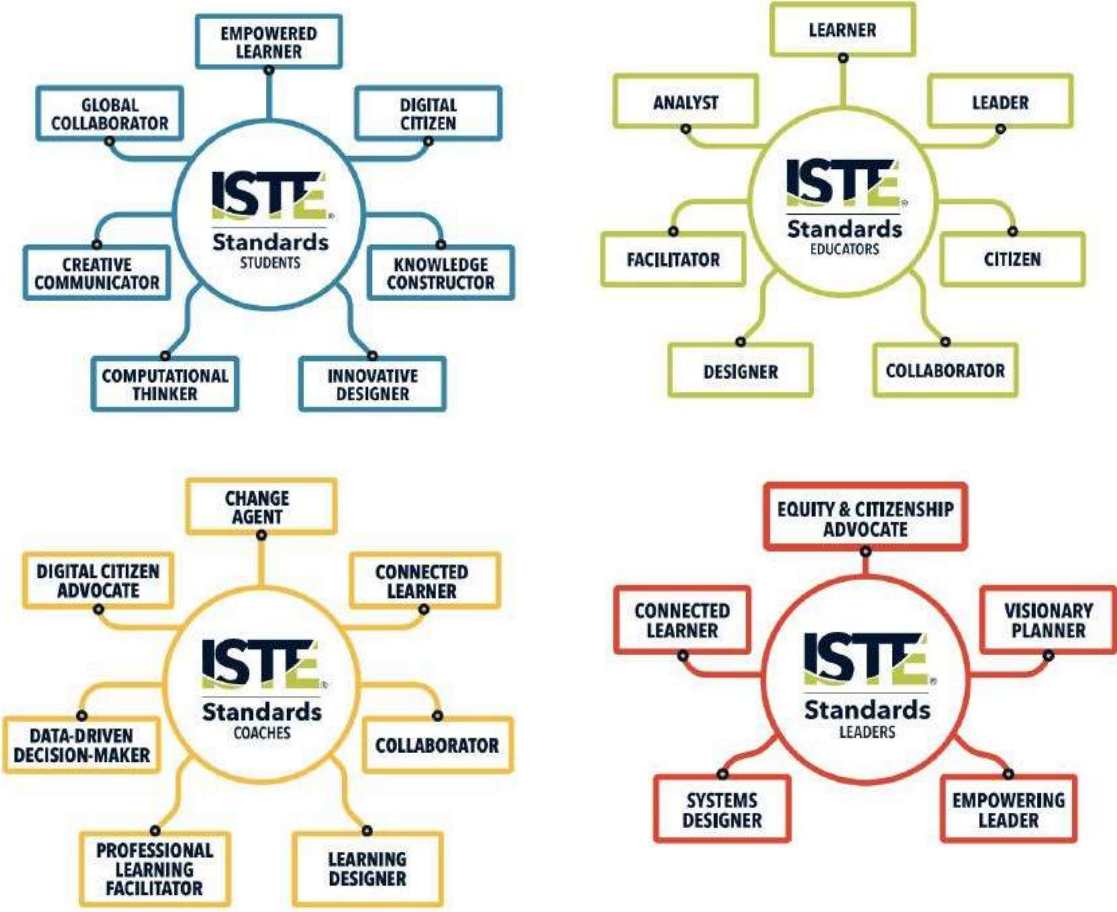

Figure 1: ISTE Standards (2022)

Figure 1 shows the ISTE standards which emphasize the need for communication and collaboration as well as design-thinking skills at all levels. Digital citizenship also plays a crucial role in 21st century learning. All ISTE standards imply skill sets that interrelate and complement each other. The Liechtenstein curriculum LiLe (2019) for example emphasizes cross-subject learning through project works where interdisciplinary competencies such as self-, social-, emotional-, subject- and methodological skills are crucial. Media and informatics in 21st century learning rather imply an overall skill set to be acquired throughout all subject areas, instead, its acquisition in isolation, when incorporated alongside ISTE standards, can become an immensely powerful tool to transform the prevalent education system to enhance 21st century learning.

2.2 Modeling structures in learning and TBA

Dhawan (2020) states: "Online learning is no more an option; it is a necessity." Knowing about the impact of the digital divide during Covid-19, the mentioned necessity still is a privilege to half of the global population. Education leadership implies not only providing the technical equipment and access to facilities but also access to knowledge about their use through professional training to aim for the development of higher order thinking skills (Kaiser, 2018). Equipping educators and learners with access to Open-Source materials, networking facilities as well as opportunities for self-directed learning within the community arises as e.g. the award-winning school Alemannenschule Wutöschingen (Germany) demonstrates. Their Open-Source digital learning platform *DILER* provides skills-based materials with the means of *MNWEG* (Materialnetzwerk, material network) according to the curriculum of Baden- Württemberg (Germany). The 8D model, moving towards 3.0, is fundamental to the learning arrangements (Alemannenschule Wutöschingen, 2017, translated):

> Through diverse pathways with diverse humans in diverse places at diverse times with diverse materials in diverse steps with diverse ideas in diverse rhythms to common goals.

Hence, facing the fact that nearly fifty percent of the world population does not have access to the internet, there is a great need to make LMS available for offline usage as well to close the digital divide.

2.3 Closing the digital divide through offline digital literacy development

The past two years were affected by massive disruptions in schooling due to the consequences of the war and the pandemic. The Eurostat's (2022) definition of the digital divide sheds light on the need to facilitate digital offline learning, especially in times of crisis with an unstable internet connection:

> Digital divide refers to the distinction between those who have internet access and can make use of new services offered on the World Wide Web, and those who are excluded from these services. At a basic level, the participation of citizens and enterprises in the information society depends on access to information and communication technology (ICT), i.e., the presence of electronic devices, such ascomputers, and internet connections.

The term explicitly includes access to ICTs, as well as the related skills that are needed to take part in the information society. The digital divide can be classified according to criteria that describe the difference in participation according to gender,age, education, income, social groups or geographic location.

This definition highlights skills that are required to participate in the information society, to which UNESCO (2018) adds the following:

Digital literacy is the ability to access, manage, understand, integrate, communicate, evaluate and create information safely and appropriately through digital technologies for employment, decent jobs and entrepreneurship. It includes competencies that are variously referred to as computer literacy, ICT literacy, information literacy, and media literacy.

Therefore, it can be concluded that digital literacy development is only complete with a digital library that fosters these skills. In this regard, digital libraries are seen as a substantial part of technology training and digital inclusion in communities (Techsoup, 2016).
Consequently, I argue that a digital library should be integral in a comprehensive school and learning management system where formative assessment and personalized learning fuel each other. Still, knowing that a large percentage of the global population does not have access to the internet and so, to Open-Source libraries, the following figure visualizes factors that influence learning with an effect on its assessment.
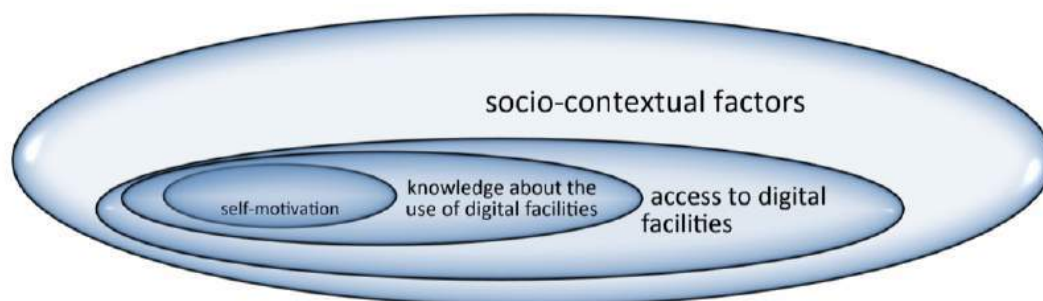
2: Unbraided components of digital literacy (Kaiser, 2018)

Figure 2 sums up the factors influencing technology-enhanced learning from a social inequalities' perspective. Self-motivation at the heart of learning interplays with knowledge about the use of digital facilities for which access must be granted. Therefore, further arrangements within the overall socio-contextual factors must be respected for which the structural setting plays a crucial role.

Addressing these factors, Hillier (2018) advocates for digital offline e-learning and e-assessment platform to bridge the digital divide, first and foremost, prevent it from widening. In this model, free and Open-Source digital learning materials are accessible offline. On the same line, the present study aims to inaugurate and explore the utility and effectiveness of the offline digital library, visible in the following table in row 7, "DigiNet".

Table 1: Comparison of devices used for offline digital libraries

S. No.	Name of device	Access method	Range of hotspot coverage	Multiple users	Download speed	Continuity of usage	Cost	Data collection for formative assessment	Miscellaneous
1	D-Link	App-based, WiFi hotspot	Limited	Limited	Reduces with multiple users	Yes	100 USD	No	Useful to access stored content
2	Teach by Tech microcomputer	WiFi hotspot	Limited	Limited speed	Reduces with multiple users	No	NA	No	Allows users only to download
3	Lexis Nexis Digital Library	Downloads from servers for offline viewing later on	NA	App based, Single user	NA	Yes	NA	No	It is a downloadable software that needs internet and a storage device
4	Mintbook	Stored content	NA	Single user	NA	Yes	NA	No	- Not suitable for bulk users - One way communication
5	Ustad Mobile	Stored content	NA	App based, Single user	NA	Yes	NA	No	One way communication
6	SolarSPELL Solar Powered Offline Educational Learning Library	WiFi hotspot, prestored content in SD card	Limited	Yes	Slow	No	NA	No	- Limited preloaded library content - Web browser search through number sequence - One-way communication
7	DigiNet	WiFi hotspot, connects to Web browser	Currently 50 m, extendable to 12 km	Up to 100 users at a time, extendable	Fast	Yes, nonstop, runs with backup power	7000 USD for minimum version	Yes	- Can load multiple software - Login ID equal to its online version

The table depicts that DigiNet outweighs other devices used to run offline digital libraries in various aspects. DigiNet cannot only work in the largest range but also accommodate many users. The number of users does not impact the upload and download speed while dynamic communication is possible as well. Whereas other offline digital libraries are single software, DigiNet can carry multiple. Since most digital libraries are designed for one-way communication where students only download the materials, educational data mining where predictions about the knowledge of students, motivational state, and educational career are not possible. Therefore, it is essential to gather data through dynamic interactions as DigiNet allows. This is vital to plan and provide the most suitable educational facilities to the fifty percent of the global population that does not have internet access and so, is disadvantaged in participating in the digital world. The offline digital library in DigiNet shall pave the way for other software to be made available in remote areas.

The server is loaded with the digital library software.

The server has got an additional cloud software to connect to external devices through the WiFi hotspot Juxtaguide.

Devices that can access the server offline include laptop, desktop, palmtop, mobile devices, both Android and Apple.

Users after registering as admin or teacher can upload and download data and files from their devices that can access the online and the offline server with the common web address juxtaguide.com. Registered students can search and download files as well as participate in chats.

The admin has the overall control over the server and its data.

The server can run 24x7 with backup power with an inverter or a battery. The server is portable.

The server maintenance can be done remotely with single point internet availability.

The offline server can be synchronized and facilitate data sharing with the online server with the same digital library software.
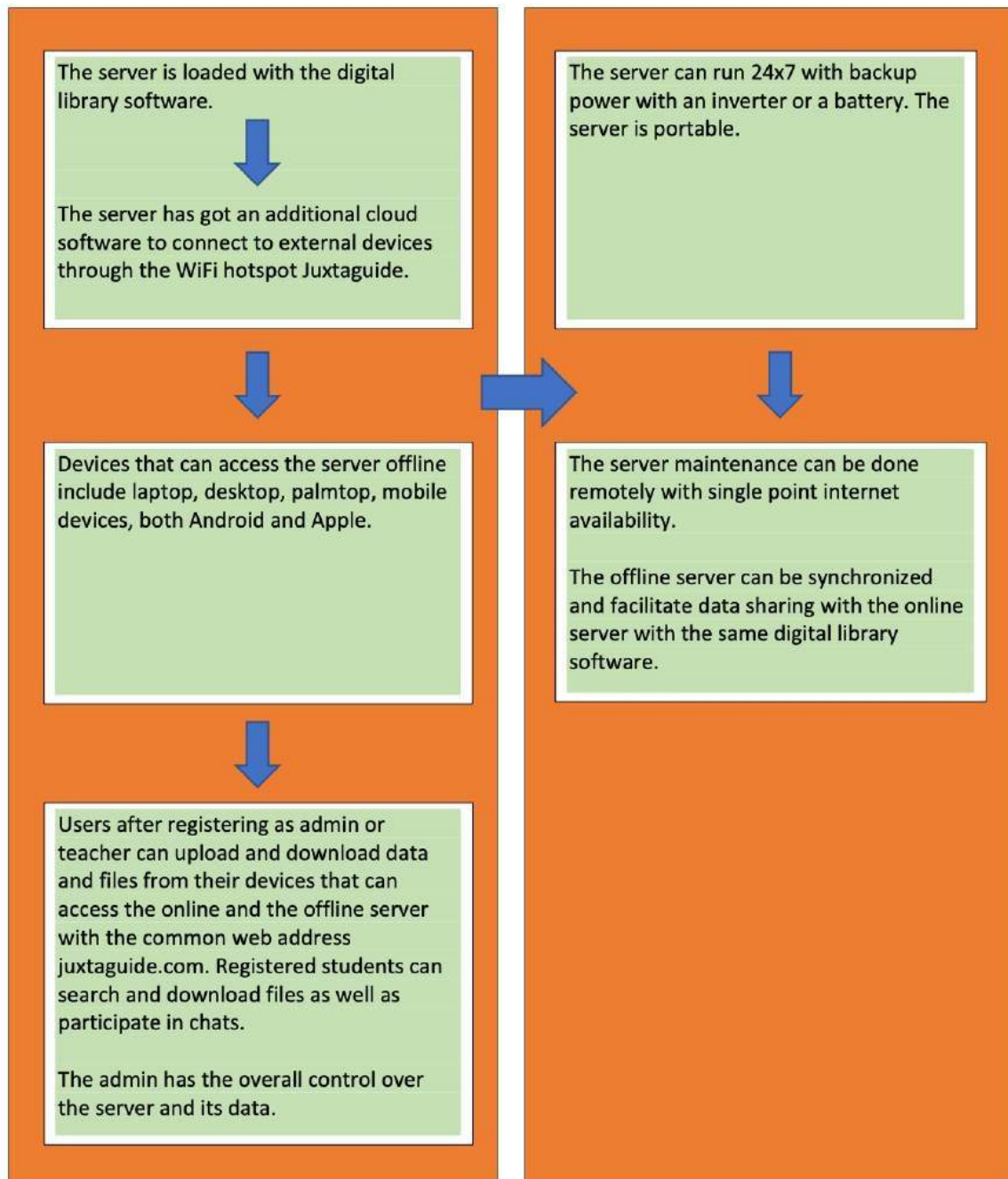
Figure 3: Flow chart of the offline server with the digital library software and its relation to the online server with the same digital library software

The flowchart is an extract from the study "Can the Offline Digital Library Boost Health Literacy in No or Low Internet Coverage Areas? - A Study on its Role and Potential to Gather Sarge-Scale Data to use for Future Planning of Learning Environments" which is about to be published. This initiates the development of data gathering in the under-researched area of digital offline learning and assessment. It contributes to facilitating access to quality education while enhancing equity, digital literacy skills, and the opportunity to maintain data in a safe and cyber-secure manner. Further, arising opportunities to archive and disseminate heritage that is not available until now shall not remain unmentioned.

The comparative study shall be done in remote areas in South India and European countries, if possible, Hungary, Germany, Switzerland, and Liechtenstein, to pioneer essential digital offline available LMS that open horizons for 21st learning and assessment programmes.

2.4 TBA: Feedback and accountability

Formative assessment and visualizing learning play key roles in 21st century learning for which meta-analyses are beneficial (Hattie and Clarke, 2018). Molnár and Csapó (2019) elaborate on the importance of feedback to enhance personalized learning while proving that learning can be made visible with regards to learning, application, and reasoning already in primary education. Therefore, the awareness of the interplay of the psychology of an individual, socio-cultural environment, and cognitive development is significant. Along the same lines, Tóth et al. (2017) claim that educational data mining is a promising means to analyze unstructured data and applied process mining enables the analysis of problem-solving behavior through visualization, clustering, and classification of data. In this context, log files provide insight into individual interactions with the assessment tool for which various data analysis methods such as sequential mining can be applied. Consequently, educational data mining and log file analysis are important means of transitioning the quality of assessment systems. According to Farrell and Rusby (2015), assessment systems become increasingly capable of assessing the performance of the learning process and so, can enhance diagnostic and formative assessment.

Therefore, with contemporary knowledge about teaching and learning as well as innovations in software and hardware development, there are approaches to combining both a school and learning management system, as visible in the above-mentioned digital learning platform and material network (DiLer and MNWEG) at the German Alemannenschule Wutöschingen (2017). Similarly, the first online High School in South Africa, the UCT Online High School (2022), provides an inclusive school and learning environment where personalized learning is the reality in a vibrant and data-driven environment.

Considering this, I argue that learning and TBA as outlined can bridge the digital divide and strive for a level playing field. It accounts for individual learning journeys and the overall performance more holistically, accurately, and with increased accountability compared to rather known summative assessment environments where paper-and-pen-based formal learning grading settings have been dominating for centuries. Especially in large-scale assessment studies such as PISA, data from the global population without internet access can be considered, as well which will provide informative data for future developments and enhance the integration to be digitally connected, bridging the digital divide. In remote areas with digital offline learning made available, the former facilitates making formative assessment possible as well. This would mean a great step towards facilitating what learning and teaching are all about: Becoming a human being that can navigate life and cope with arising challenges appropriately.

3   Research questions

Csapó et al. (2012) outline a variety of research areas and questions to conduct research to enhance TBA. Of these, especially the possibility to collect, store and analyze data of longitudinal studies by the means of TBA is of interest in relation to digital offline learning to access and use data for development that could not be done in this way so far. Also, it is of great interest to investigate the characteristics of data tracing that provide insight into the quality and effectiveness of a student's learning process. In this regard, also the measurement of emotions can provide valuable insights into how to set up a LMS with integrated assessment.

Having explored the state of the art and innovations to foster 21st century learning and assessment where digital literacy plays a crucial role, especially for those who are not connected to the internet, such learning and assessment opportunities are far from reality. Therefore, the following overall research questions result from the findings to conduct a series of studies to adhere to the cumulative structure of this dissertation.

1. What is the effectiveness and usability of DigiNet tested with the means of the offline digital library in remote areas in South India, Hungary, Germany, Switzerland, and Liechtenstein?

2. How can digital literacy skills be taught more effectively using DigiNet with the offline digital library to equip the future workforce with skills required to master the PostCovid19-crisis and consequences of the war?

3. How can problem-solving skills be fostered by the means of offline digital learning with integrated assessment?

4. How can heritage be archived and disseminated effectively by the means of digital libraries?

5. What is required to establish a technology-based Learning and Assessment System?

5.1 What does the training need to look like to acquire the digital skillset to teach and learn by the means of the same?
5.2 Which accreditation requirements need to be met to train professionals globally?
5.3 How can a framework including local standards combined with CEFR and international standards for 21st century learning enhance the transnational accreditation of such an establishing schooling programme?

4   Research Design

After in-depth research about digital offline learning facilities, digital libraries, TBA of problem-solving skills, and challenges to surpass the digital divide, data for further insights regarding the questions need to be collected. Semi-structured interviews shall be conducted, analyzed, and interpreted. Elaborating on the latter, extensive fieldwork with studies is required to develop a respective programme with regards to resource allocation, scalability, and socio-contextual factors that influence learning. Schools provide the testbed

for research about human and material resources such as infrastructure, methodology, concept, and strategy. Studying the structural organization of best practices in remote areas shall give insights into trends and possible pathways to conduct further research.

Therefore, the first part of the dissertation consists of a literature review to elaborate on the current situation. Therefore, literature will mainly be accessed through journals. Methodologies, models, (national) policies formative TBA, and digital offline learning models to bridge the digital divide shall be examined in depth. Research trends and gaps that arose especially during the pandemic and the war provide opportunities to investigate.

This research shall provide a deeper insight into extreme trends of how schools themselves and states with policies at a larger scale equip students with future skills and where they struggle to reach out to their students.

A framework including future skills development as well as an action plan for its implementation through a school and learning management system as mentioned above shall result from the action research done in remote schools. This facilitates tracking the process of skills acquisition through integrated technology-based assessment of individuals to address the need to overcome perceptual and systemic barriers and provides 21st century learning opportunities through technology-based teaching, learning, and assessment digital offline to reach out to the tremendous number of students without internet access.

5   Project Plan

The duration of the doctoral studies at the University of Szeged is 2+2 years. The first two years include courses and research. To complete this stage, an examination takes place to evaluate the subject knowledge in the research field and the research work. Afterward, the research plan is to be presented for the following two years, consisting of research only. The dissertation defense starts after the successful completion of the former. Therefore, the study period will be four years, 2022-2026. Conferences to present preliminary studies are part of the process in education with the first supervisor Prof. Dr. Benő Csapó and the second supervisor Prof. Dr. Ingo Barow. Carrying out a cumulative and paper-based dissertation, publications are part of the study period itself. Conferences, especially in the field of digital skills acquisition about digital libraries and digital offline learning and assessment, are targeted to present preliminary findings. There, three papers written in this cumulative Ph.D. will be presented. It is aimed to publish the papers in high-ranked journals embracing studies in educational technology, educational psychology, and social research.
After the preparation phase, a preliminary study to be published is a literature review that aims to enlighten the state of the art. The methodology of the write-up of the dissertation and further developed project plan are part of the research proposal. The latter needs to be presented in the colloquium to proceed with the Ph.D.

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¹ Background information DigiNet and digital library

7   Declaration of originality

I hereby confirm that I am the one and only author of the written work enclosed. I have used my own words.

Chennai, 24th July 2022

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Evamaria Brigitta Kaiser