Article

Sustainable development goals through participatory video and digital storytelling

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Abstract: This study focuses on a training experience that took place in the academic year 2021–2022 at Gadjah Mada University in Indonesia. A hands-on workshop on ICTeEfS focusing on Participatory Video (PV) and Digital Storytelling (DST) involved 210 teachers in the creation of videos with a two-fold objective: 1) embedding SDGs in school curricula enabled by PV/DST methodologies and 2) innovating teaching methodologies by merging digital and green skills. The process of creating PV/DST videos included a 15-step methodology integrated into four interacting phases starting from planning, moving to production, and then utilization/dissemination. The PV/DST applications produced could be used as learning resources to enrich the school curricula. Uploading PV/DST to school or social media accounts was a good method to get the message out to a wider audience while empowering teachers to address SDGs. The results can be used as guiding principles for teacher educators and teachers as well as for policymakers to integrate PV/DST in teaching, learning, and curricula addressing SDGs.

Keywords: SDGs'; sustainable development goals; participatory video; digital storytelling; ICTs; education for sustainability; green skills; digital skills; teacher training

1. Introduction

Southeast Asian countries are currently facing thesignificant impact of the sustainability crisis caused largely by unsustainable modes of production and consumption [1,2]. Research shows thatIndonesia's wealth of natural resources is being highly exploited to serve economic growth, while environmental awareness and knowledge among the populace are limited [3]. To achieve the transformational shift towards a more sustainable and just society there is a need for more equitable and responsive relationships between humans and nature. Currently, society is undergoing an increased digital transformation across all societal and economic sectors [4–7] and education should not be left behind. Education for sustainability becomes an important research area for embedding SDGs in school curricula [8] which could lead to a low-carbon sustainable development [9] and reduction of the negative impact of resource exploitation and environmental pollution [10].

The calls for taking action communicated through global initiatives such as the European Green Deal [11] and the UN 2030 Agenda for Sustainable Development

[12], and in particular the 17 Sustainable Development Goals (SDGs) which have launched the transition to a greener economy and society. Indonesia is one of the largest countries in the world and the largest among the Association of Southeast Asian Nations (ASEAN) in terms of population, Gross Domestic Product, and a fast-growing digital market that demands digital skills to accelerate the pace of its digital transformation and overcome the existing digital divide [13–15]. Recent policies in Indonesia prioritized the greening of the economy through the implementation of SDGs supported by digital transformation [16–18]. The Indonesian government has paid due attention to the transformative power of the creative and circular economy and has undertaken various initiatives to stimulate sustainable growth in this domain [19,20]. Indonesia's efforts toward digitalization generated through favorable policies and incentives have increased attention both locally and globally [21]. Green and digital skills are crucial for climate neutrality as well as for employability and entrepreneurship [22,23]. On the one hand, essential digital skills, such as being able to handle digital devices, find, adapt, and modify digital learning objects on the Web, as well as understanding ethics, risks, and opportunities are challenging all education levels. On the other hand, green skills such as possessing knowledge, values, attitudes, and action competencies needed to live together sustainably are equally positioned as necessary constituencies across all education levels.

Indeed, in an era where digital transformation and environmental sustainability meet together, Indonesia and humanity, in general, are faced with one of the most warning challenges in history to face the convergence of green and digital education. In particular, the critical role of digital technologies in addressing environmental challenges, such as consumer behaviors as a means of mitigating the effects of climate change is highly acknowledged [24,25]. The role of education, starting from pre-service teachers at Faculties of Education and continuing with in-service teachers at the primary and secondary school levels, is of critical importance. In particular, the growing importance of soft or transversal skills such as the 4Cs (Communication, Collaboration, Critical thinking, and Creativity) [26] and its extension to 10Cs [27], adding Critical reflection, Critical consciousness, Connectivity, Co-responsibility, Constructing knowledge and Cross-cultural understanding lies at the heart of converging green education with digital education. These skills are necessary to unlock human agency and equip the next generation of changemakers. However, it has to be stressed that despite growing up in a digital and hyper-connected world, not all of today's students have the digital skills required to use technology effectively, especially in the context of real-life issues that can be visible across the 17 SDGs [28,29]. The digital divide is not only situated with accessibility to the Internet but also about the existing awareness-knowledge-action gap for living together sustainably [30,31]. Addressing these gaps can help support the UN Sustainable Development Goals (SDGs), including Goal 4 (providing equitable access to quality education) and Goal 13 (climate action).

Thus, education at all levels should play a key role in developing digital skills for all students. The rapid growth of digital education in the post-COVID era paves the way for innovative practices towards merging with green skills enabled by innovative approaches to teaching, learning, and curriculum reconstruction. This

convergence can enable young Indonesian people who represent almost half of the population to manage their carbon footprint, preserve biodiversity, and promote sustainable development more effectively [19]. An issue brief for the Government of Indonesia states that if current trends persist, by 2030 more than 60% of young people may lack the skills required to thrive in the green economy [32]. Green skills will allow young people to be better prepared to act as catalysts and lead the transition to a greener future [22,33]. Research shows that Participatory Video (PV) and Digital Storytelling (DST) can be seen both as teaching methods and learning resources that can promote the merging of green education and digital education at all education levels [34,35].

The merging of green and digital skills connected with local issues elicited from the 17 SDGs enabled by PV/DST methodologies and tools was one of the key areas that the ICTeEfS (ICT-enabled Education for Sustainability) in-service teacher capacity building program funded by the European Commission. The program targeted teachers in Indonesia to get a deeper insight into the country's efforts for green and digital transformation and the role education can play in this effect. The training was designed to involve in-service teachers in learning and practicing digital tools and innovative pedagogical strategies to embed education for sustainability and in particular SDGs into teaching, learning, and curricula. It was envisaged that ICTeEfS focusing on PV/DST would unlock opportunities for revising teaching methods and curricula and turn teachers into active players in developing learners' green and digital skills. Thus, the research questions addressed in this study include the following: What are the most frequent subjects infused with SDGs? What is the preferred length of the PV/DST applications? Which SDGs are more attractive to get infused in the PV/DST applications? What lessons can be learned through the contextualization of SDGs with digital skills generated through the development of PV/DST? What kind of green skills can be inferred through the infused SDGs? How do the PV/DST activities connect with the Indonesian policies and practices for implementing the UN Agenda for SDG?

2. Materials and methods

Participatory video (PV) and digital storytelling (DST) can be merged to provide a methodology in which a group creates their own video usually to advocate their concerns and explore possible solutions to an issue that they are concerned about [36]. Thus, PV and DST bring together interested stakeholders to tell their stories to the wider community, a process that can activate self-reflection, empowerment, and action [37–39]. The PV/DST methodology is characterized by a horizontal decision-making process, collaboration, dialogue, and co-construction of knowledge to serve various purposes [40,41]. Using a PV/DST methodology unlocks the opportunity for those involved to communicate their ideas, perspectives, world views, and experiences to the broader community, and other stakeholders [42–45]. It is driven by a critical-reflective attitude and an emancipatory perspective leading those involved to learn to transform themselves and society. In other words, the PV/DST process leads to empowerment, critical reflection, community service, and giving voice to those who could otherwise not be heard [46–48]. The process of

creating PV/DST includes some procedures, starting with planning, production, utilization, and dissemination. The PV/DST methodology applied here was based on Makrakis and Kostoulas-Makrakis [49] 15 steps structured on four interlinked stages, named the PV/DST4Ps: 1) pre-planning (Steps 1–4), 2) planning (Steps 5–9), 3) production (Step 10–13), and 4) publication (Steps 14–15). In the pre-planning stage, each group started with an idea referring to a sustainability issue as part of the capacity-building program, and continued with searching PV/DST examples from the Web, preferably dealing with education for sustainability issues (Step 1). Based on the search results, participants proceed to a thorough analysis of the inherent goals, objectives, and messages conveyed (Step 2). After getting a thorough knowledge of what exists in this field, the leaders of the teacher training program developed an example to be used as a model for trainees and organized the groups to be involved in the PV/DST process (Step 3). In forming the groups, particular emphasis was placed on group communication through (Step 4): 1) creating friendly, trustful, and egalitarian relationships among the people involved in the project and 2) sensitizing the group members to the issue and tasks as well the potential for transforming their teaching and learning practices.

During the planning stage, that is, the most critical step to producing a successful and meaningful PV/DST application, the starting point includes the setting of goals, objectives, and strategies (Step 5), conducive to the PV/DST application to be developed, following up by deepening the inquiry (Step 6) for specific resources focusing on the content issue or theme and scheduling (Step 7) and to establish a realistic timeline for the entire PV/DST project. Upon that, participants in each group are in a position to proceed with scriptwriting/revising the PV/DST script (Step 8). Scripting is a process that generates the development of the storyboard that provides the plotting, that is, the sequence or the roadmap of the events taking place in the plot. The visualization and dramatization what is referred to as the process of storyboarding (Step 9) graphically describes the action that will take place in each scene of the PV/DST application.

In the production phase, starting with the editing process (Step 10) one of the most demanding tasks that requires special care and skills, including the refining of titles, text, and credits (Step 11): Although this may be part of the editing step, this can also be done as a separate step. This process continues with logging and capturing footage (Step 12), using the appropriate software tools. Formative Assessment (Step 13) focuses is testing and validation that culminates with the publication phase, including the uploading to a media platform (Step 14), usually on the web (YouTube), ending with publication and dissemination (Step 15) to interested stakeholders and the wider public.

The PV/DST methodology was part of the ICTeEfS capacity-building program at the University Gadjah Mada (UGM) in Indonesia. The training was organized in three consequent cohorts. It started with a train-the-trainer session (1st cohort) from the University of Gadjah Mada (UGM), continued with the in-house training of in-service teachers (2nd cohort), and culminated with a follow-up training for all subject teachers (3rd cohort). All the training sessions were highly supported by local educational authorities. In these workshops, particular emphasis was given to

the participatory and negotiated curriculum development approaches [50,51], the six pillars of learning (learning to know, learning to be, learning to do, learning to live together sustainably, learning to give/share, and learning to transform oneself and society), as well as the 10Cs of transversal skills needed for 21st-century education [27,52]. The epicenter of the training was the merging of all these innovations with the embedment of SDGs in school curricula enabled by PV/DST methodologies and digital tools.

3. Results and discussion

3.1. Pre-planning PV/DST

Starting from the train-the-trainer workshop at the University of Gadjah Mada (UGM), 15 teacher trainers (8 female and 7 male) were trained to lead the in-house training of teachers. In total 210 teachers from the province of Yogyakarta in Indonesia, 72% of whom were women were trained to lead further training sessions within their schools and educational districts from November 2021 to January 2022. The ICTeEFS in-service teacher training participants are teaching a wide array of courses reaching up to 33 (**Figure 1**).
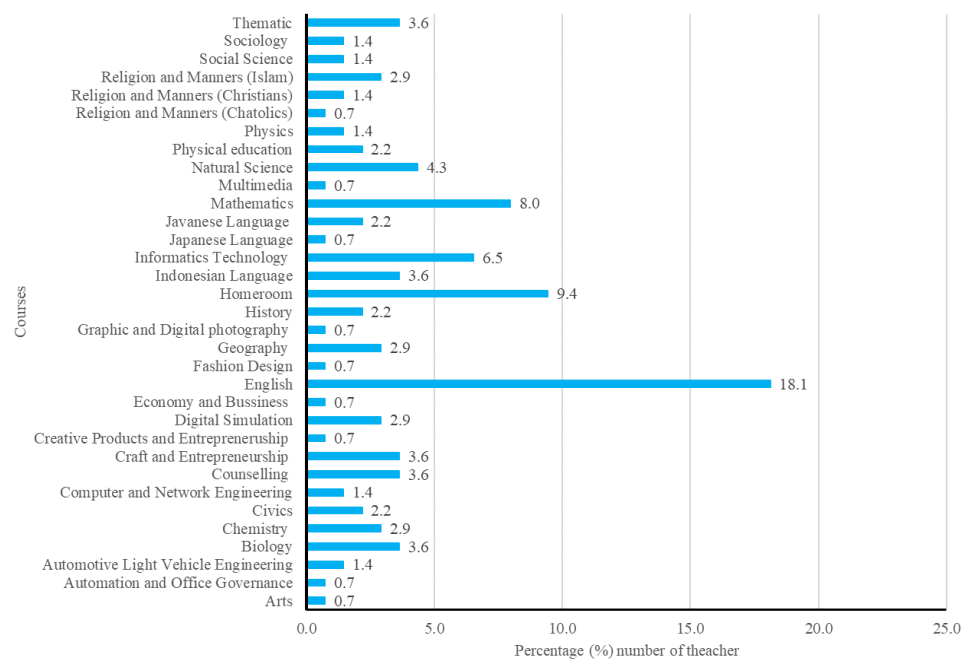
Figure 1. Subject taught by teacher trainees.

The trained teachers represented the three levels of school education, namely: primary, junior high school, and senior high school in the Special Region of Yogyakarta, an area of 3186 km^2, with 3.7 million population and 3042 schools at the primary to secondary level [53–55]. Although the majority of the teachers were working in urban schools, a significant part was also from rural schools. **Figure 2** shows the spread of the trainees' schools in the Special Region of Yogyakarta. The mandatory schooling in Indonesia lasts for nine years, consisting of elementary (6 years) and junior high school (3 years). There are two different types of high school, which are regular high school and vocational ones. These two types of schools have

quite distinct learning environments. While the vocational ones will prepare students to enter the workforce, the regular high schools will focus more on preparing students for the next level of education (college).

Figure 2. Geographical distribution of schools.

During the pre-planning phase, teacher trainers and facilitators introduced the concept of PV/DST and how it will be operationalized in merging green education and digital education in the context of SDGs. Trainees were given examples of PV/DST and they were asked to do their searching on the Web to identify PV/DST applications, preferably dealing with education for sustainability issues. Our experience through the ICTeEfS training sessions showed that as a starting point, trainees searched for a local sustainability issue that has drawn attention to the local society in connection with SDGs and at the same time reflected on their previous experiences in the field. Teacher trainers also developed an example to be used as a model for trainees. Through these pre-planning activities, teacher trainers aimed to sensitize teacher trainees to real-life issues that could be transformed into teaching and learning materials. Throughout the pre-planning phase, trainees were engaged in conceptualizing what should be developed and why as well as identifying what digital and green skills were lacking to be addressed in the training sessions. Our experiences show that what was mostly lacking was the skill of how to merge green and digital skills through engagement in developing PV/DST infused with SDGs. Creating a dynamic, interactional, and transformative dialogue about the significance of the PV/DST application was perceived as a critical strategy in providing teacher trainees with the knowledge and skill to be actively involved in the subsequent planning phase. As teacher trainers, we realized that PV/DST integration is complex, and trainees lacked the pedagogical knowledge necessary to integrate digital tools effectively in their everyday teaching work.

3.2. Planning PV/DST

Within the context of the ICTeEfS teacher training program, digital and green literacy were seen as a prerequisite to turning PV/DST planning into a meaningful process and learning activity. In the planning phase, teacher trainees were required to organize the PV/DST projects requiring them to design and compose digital multimodal texts in line with the objectives set and the SDG themes (**Figure 3**) they

identified as the most suitable ones in the local context. They were asked to reflect on the process and consider the advantages of integrating PV/DST in their classroom teaching and the school curricula. Our experiences as teacher trainers show that teacher trainees were not used before in PV/DST scripting and the related skills using multimodal resources in developing learning objects with the support of ICTS. Efforts were directed toward communicating the message that the script should be perceived as a process and not as a product. The storyboarding process was highly facilitated by a storyboard template used as a graphic organizer. The collection of the PV/DST multimodal elements such as images, text, music, and animated features were chosen in line with written scripts to allow trainees to proceed with the production processes.

Figure 3. SDGs adapted from UN https://sdgs.un.org/goals.

3.3. Production of PV/DST

At the end of the training, 132 PV/DST applications had been developed representing 104 primary, junior secondary, and senior secondary schools (**Figure 4**). **Table 1** summarizes the results of these applications. It has been revealed that the majority of the produced PV/DST applications are mostly found in the subjects of Sciences/Mathematics and Civics followed by Languages. It is worth pointing out that these three subjects are also more frequently represented with school grades than the other subjects. Surprisingly, the least represented subject is Natural Studies, although it is the one that shows the highest infusion of SDGs in the produced PV/DST applications. It is also surprising that Religion is a subject that shows a high infusion of SDGs compared to other school subjects. In terms of the length of PV/DST applications, the majority ($N = 58$) exceeds 11+ minutes, followed by less than 5'. The allocated amount of time/learning unit in Indonesia is regulated by a Decree from the Minister of Education, Culture, Research, and Technology No. 16 referring to the Standardized Process of Education for Kindergarten, Pre-School, Elementary School, Junior High School, Regular High School, Vocational High School, and Equivalent level of schooling [56]. It has been revealed that only three SDGs, namely SDG 11 (Sustainable Cities and Communities), SDG 14 (Life Below Water) and SDG 17 (Partnerships for SDGs) are missing from those infused in the content of PV/DST applications. The results show that the most frequently infused

SDGs were those of SDG 3 (Good Health and Well-being), SDG 4 (Quality Education), SDG5 (Gender Equality), SDG 7 (Affordable and Clean Energy), and SDG 13 (Climate Action). It has been also revealed that teacher trainees from grades 7th and 3rd are the ones where most of the PV/DST applications have been produced.
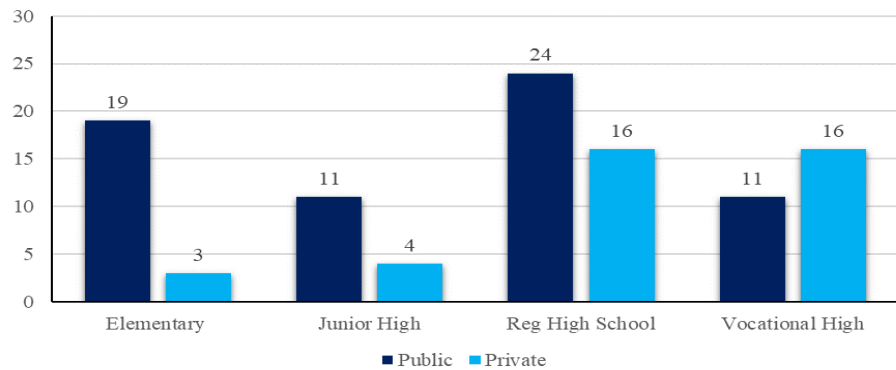
Figure 4. School level and number of participating schools.

Table 1. Distribution of PV/DST applications by subject areas, grade school level, length, and SDGs infused.

Subject areas	Grade	School level	PV/DST length in minutes				SDGs (1–17) infused in PV/DST
			0–5	6–10	+11'	Total	
Natural Studies	7	Junior Secondary			1 video	1	3, 4, 5, 7, 9, 10, 13
Sciences/Math	1, 2, 7	Primary & Junior Secondary	11 videos	8 videos	22 videos	41	1, 2, 4, 12, 16
Social Studies	5	Primary	8 videos	3 videos	5 videos	16	7, 8
Arts & Culture	3, 7	Primary & Junior Secondary	5 videos	1 video	5 videos	11	5, 8
Languages	7, 10	Junior and Senior Secondary	7 videos	9 videos	14 videos	30	3, 10, 13
Health & Sport	4, 6	Primary	1 video	2 videos	3 videos	6	1, 3, 4
Religion	7, 11	Primary & Senior Secondary	5 videos	1 video	1 video	7	3, 5, 6, 13, 15
Civics/Pancasila	3, 4, 7	Primary & Junior Secondary	1 video	1 video	2 videos	4	2, 4, 5, 16
Cross-thematic	3, 6	Primary	7 videos	4 videos	5 videos	16	7, 15
Total			45	29	58	132	1, 2, 3.4, 5, 6, 7, 8, 9, 10, 12, 13, 15, 16

3.4. Publication/Dissemination

One of the key strategies applied concerns the dissemination of the PV/DST applications which reflects the motto "Sharing is caring". Participants were encouraged to share what they had produced and learned during the training period not only within the groups but also between the schools and beyond to the wider teaching community and public. This was achieved through the use of various social media platforms such as YouTube. A total of 2305 people were reached (**Figure 5**).
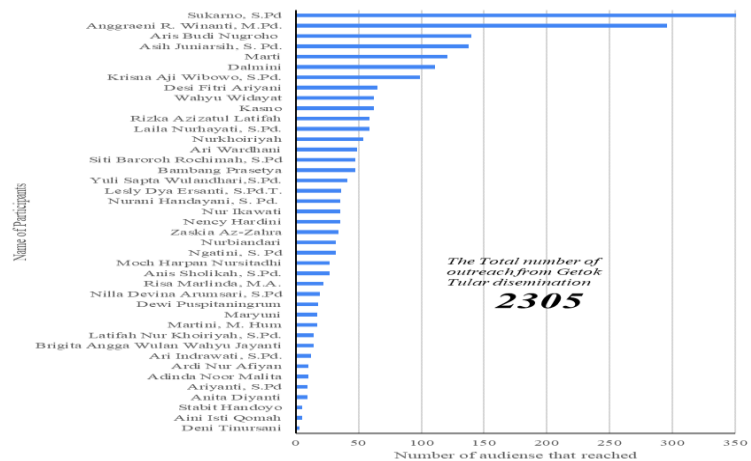
Figure 5. PV/DSTdissemination results.

4. Discussion

Our purpose in this study was to enable both teacher educators and in-service teachers how they can foster the development of digital and green skills needed for quality education (SDG 4). By digital skills, we referred to both the technical and creative skills involved in using digital media tools to develop PV/DST applications for teaching and learning as well as for enriching the school curricula. In the ICTeEfS teacher training program, digital and green skill-building was both a key objective and a byproduct of the PV/DST training activity. Several studies have shown that PV/DST is not only an effective pedagogical tool but also a tool that can empower participants to rethink teaching, learning, and curriculum perspectives as well as their roles as teacher educators and in-service teachers [55–57]. Our PV/DST methodology differs from previous similar ones in four ways: 1) attempts to contextualize green skills with digital skills; 2) integrates cross-cutting sustainability issues largely elicited from the 17 SDGs; 3) provides an inquiry-based approach that is driven by transformational teaching and learning principles and 4) helps to cultivate a participatory and digital storytelling culture for empowering teachers to address SDGs in multiple school subjects.

Among the key questions posed besides the ones that were explored in the result section were: What lessons can be learned through the contextualization of SDGs with digital skills generated through the development of PV/DST? What kind of green skills can be inferred through the infused SDGs? How do the PV/DST activities connect with the Indonesian policies and practices for implementing the UN Agenda for SDGs? Based on the results presented in **Table 1** and our reflections and discussions with teacher trainees during the training sessions the following lessons can be learned.

- ICTs and digital resources are essential means of training, acquiring, and co-constructing new knowledge that can generate new pedagogical practices.
- Using PV/DST as a teaching and curriculum development methodology offers teachers the opportunity to deal with local real-life issues with particular reference to SDGs.

- The teacher's role is fundamental to the infusion of SDGs in course curricula by employing PV/DST as innovative teaching methodologies, and content that is driven by real-life issues.
- PV/DST focusing on green issues generates many digital skills that help reflect on teacher trainees' personal theories and practices.
- Education leadership plays a key role in the implementation of SDGs and the PV/DST integration in teaching, learning, and curriculum enrichment.
- Interpreting the high outcome of viewing the PV/DST applications, it can be assumed that sharing PV/DST not only serves to "raise awareness" on real-life issues but also by turning teacher trainees "becoming visible" through the dissemination of their work can lead to an empowering and multiplier effect.
- Working closely with in-service teachers facing various challenges in their teaching practices taught us that what actually may matter more is how to bring the school to society and vice versa.
- By using PV/DST methodologies to merge and enhance green and digital skills, the ICTeEfS project opened spaces for the in-service teachers to reflect, learn, and talk about a wide array of sustainability issues elicited from SDGs that are not usually discussed in their classes.
- The convergence of digital technology and education for sustainability is one of the most significant pathways for creating meaningful synergies where digital technologies meet with the greening of teaching, learning, and curricula.
- The themes integrated or infused within the PV/DST learning products may serve as a means to raise teacher trainees' critical consciousness on SDGs issues, reflect on previous teaching practices, and consider changing personal theories on teaching, learning, and curricula,
- For us as teacher trainers, it was critical to create an open dialogue, ensure trust, share knowledge and experiences, discuss challenging issues, and question dominant ways of teaching, learning, and being.

All these assumptions and interpretations derived from the study results have strong support in previous research. It has been also shown that digital teaching and learning across all education levels can significantly contribute to learning to transform oneself and society [58,59]. Developing, producing, using, and disseminating digital applications contextualized with sustainability issues can significantly contribute to changing unsustainable actions that have led to the current climate crisis [60]. Teacher education and in-service training play a crucial role in building the capacity of future and current teachers to contextualize green education with digital education [61,62]. Teaching quality spelled out in SDG4 requires a more systematic integration of Education for Sustainability (EfS) across all education levels in Southeast Asia, starting from primary and secondary school education to teacher education [63]. Teachers are the key drivers in embedding the UN 2030 agenda for SDGs in teaching, learning, and curricula [64]. However, the teacher- and system-level barriers should be given special attention for a successful infusion of SDGs in education [65]. PV/DST both as teaching methods and as supplements to classroom-based activities are conducive to education for sustainability and digital literacy [66], merge several media such as image, video, sound, and music to

contextualize a story that may convey messages cutting across the four pillars of sustainable development [67]. The use of digital technologies in education can address sustainability issues largely elicited from SDGs and provide students with an interactive and engaging learning experience, unlocking opportunities for creative real-world problem-solving [68,69].

The research results also show that the most frequently infused SDGs refer to SDG3 (Good Health and Well-being; SDG4 (Quality Education); SDG5 (Gender Equality); SDG7 (Affordable and Clean Energy), and SDG13 (Climate Action). Good Health and Well-being' has unsurprisingly received attention from teacher trainees. This may be explained by the fact that the training was implemented by the end of the COVID-19 pandemic and the health crisis seemed to present an opportunity for Indonesian teachers to address this SDG in teaching, learning, and curriculum development through PV/DST. The situation during the pandemic revealed that Indonesian teachers as in many other countries were not ready to tackle the problems caused by the pandemic. Indonesia is also the world's fourth-largest populated country with unique socio-cultural and multi-ethnic characteristics, as well as a rising economic power that makes critical healthcare a hot issue, related to Indonesian wellbeing [70].

It was also unsurprisingly that gender issues appeared to be highly preferred as core themes in the PV/DST applications developed by teacher trainees. Perhaps, the reason for choosing gender issues among the teacher trainees is that Indonesia experiences more gender inequality than other neighboring countries taking into consideration its level of economic development [71], despite the enaction of legislation governing the rights of women [72]. It is worth pointing out that Indonesia's female labor force participation rate is comparatively low compared to the region, and has remained unchanged over the last two decades despite structural changes to the economy and higher female education performance in school subjects [73–75]. In connection to the quality of education that is highly debated, traditional modes of teaching and learning still predominate in its education system [76]. It is hoped that the various capacity-building initiatives such as the ICTeEfS program supported by the European Commission will contribute to shifting transmissive teaching and learning to constructivist and transformative alternatives that are more suitable to meeting the demands for merging green and digital skills addressing SDGs. Indeed, one of the most recurring strengths attributed to the development of PV/DST applications as part of the training process was its potential to enable reflection and rethinking of dominant perceptions of teaching, learning, and curriculum development. Such an assumption seems to be supported by previous research showing that PV/DST helps to cultivate a participatory culture of a group of people that can ultimately generate positive changes related to quality education [77–79]. It is also worth pointing out that the length of the PV/DST applications does play a critical role in their integration into teaching, learning, and the school curriculum. Taking into consideration the structure of the Indonesian school system, the most suitable PV/DST applications that could be used in offline learning were the ones that have short to medium lengths of time (5–30 minutes). Video with short-medium lengths are more suitable to Indonesia's study timeframe study unit which is

35 minutes for elementary school, 40 minutes for junior high school, and 45 minutes for senior high school and vocational high school.

5. Conclusion

This project challenged teacher educators and teachers to design and create PV/DST as part of a capacity-building program and of teaching, learning, and curriculum enrichment. A participatory video is a useful tool for promoting SDGs and the principles of Education for Sustainable Development. As it has been argued in the discussion section, digital technologies can support the greening of pedagogy and curricula which in turn unlocks opportunities for transformational teaching and learning. Teacher capacity-building programs should play a critical role in merging digital education and green education through which teachers can be involved in participatory and collaborative efforts of designing and making digital artifacts such as PVs. Through this experience, we have learned that learning should be 1) anchored on and driven by participants' interests, 2) powered by collaborative efforts, and 3) oriented toward real-life experiences.

Exploring the dynamic nature of PV/DST in the context of green education and in particular with SDGs is essential for bridging the awareness-attitudes-knowledge-action gaps and helping in merging digital and green skills. Therefore, this project aimed to bridge these significant gaps through a capacity-building program in the Yogyakarta periphery led by the University of Gadjah Mada. This endeavor is not only pertinent to teacher educators and teachers but also to educational policymakers and stakeholders within Indonesia. In this perspective, we also aim to draw lessons and inspiration for innovative teaching and learning practices that can be applied in various local, regional, and global contexts. As green education enabled by digital technologies continues to reshape education structures, teaching, and learning processes, education locally and globally is confronted with the imperative task of shifting from transmissive to constructivist and ultimately transformative pedagogies.

The present study has some limitations that need to be addressed in future research. First, there is a need to measure the learning outcomes of such PV/DST methodologies and practices in classrooms on sustainability behaviors. Further, the study was exploratory in nature, aimed at integrating a PV/DST methodology as part of a teacher capacity-building program to embed sustainability and SDGs in teaching, learning, and curricula. When conducting similar interventions in the future, it is suggested to complement with a follow-up investigation of possible learners' experiences during the use of PVs/DST in class. It is also important to connect the SDG themes with the school curriculum applying inter/cross-disciplinary teaching methodologies. Such a connection could help to find which lesson unit and subject PV/DST fits better. Despite these shortcomings, digital and green education, PV/DST, and ICTs are essential components of the implementation of the UN Agenda for SDGs and the European Commission Green Deal, both in terms of strategic innovation, pedagogy renewal, teacher training, and inclusive school development.

Author contributions: Conceptualization, VM, NKM, ZR and NAF; methodology, VM and NKM; validation, NKM, and VM; investigation, ZR, LH, NAF, SRP, BRA and IDP; resources, VM and NKM; data curation, VM, ZR and NAF; writing—original draft preparation, VM, ZR, LH, SRP, NKM and NAF; writing—review and editing, VM and NKM; visualization, VM, ZR, LH, IDP and NAF. All authors have read and agreed to the published version of the manuscript.

Conflict of interest: The authors declare no conflict of interest.

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