

## Empowering Inclusive Design Education in the Pensil Kertas Community Through a Text-based Prototype and Digital Approach

Muhamad Riyan Nugraha<sup>1\*</sup>, Ranti Rachmawanti<sup>2</sup>, Lira Anindita Utami<sup>3</sup>

<sup>1,2,3</sup>Master's Program Student in Design, Universitas Telkom, Bandung, Jawa Barat, Indonesia

\*Email corresponding author: [muhamadriyannugraha@student.telkomuniversity.ac.id](mailto:muhamadriyannugraha@student.telkomuniversity.ac.id)

Article Info	Abstrak
<p><b>Article history:</b> Received 12-04-2025 Revised 11-08-2025 Accepted 10-11-2025 Published 14-11-2025</p> <p><b>How to cite:</b> Nugraha, M. R., Rachmawanti, R., &amp; Utami, L. A. (2025). Empowering Inclusive Design Education in the Pensil Kertas Community Through a Text-based Prototype and Digital Approach. <i>Edcomtech: Jurnal Kajian Teknologi Pendidikan</i>, 10(2), 179–190. <a href="https://doi.org/10.17977/um039v10i22025p179-190">https://doi.org/10.17977/um039v10i22025p179-190</a></p> <p>© The Author(s)</p>  <p>This work is licensed under a Creative Commons Attribution-ShareAlike 4.0 International License</p>	<p>Sejak 2009, Komunitas Pensil Kertas berperan dalam mendukung pendidikan desain secara non-formal dan inklusif di Kota Bandung, dengan kegiatan kolektif menggambar serta program pelatihan bagi peserta dari jenjang sekolah dasar hingga dewasa. Namun, komunitas ini menghadapi berbagai tantangan selama masa hiatus pada tahun 2019-2024. Penelitian ini mengkaji tantangan dan kesenjangan tersebut, serta juga mengeksplorasi transformasi aktivitas komunitas yang fokus pada pendidikan dengan pendekatan digital melalui text-based prototype dan solusi digital untuk memperkuat ekosistem kreatif komunitas ini. Selaras dengan Sustainable Development Goals (SDGs) poin 4 (pendidikan berkualitas) dan 11 (kota berkelanjutan), studi ini mengadopsi pendekatan participatory design untuk meningkatkan interaktivitas dan aksesibilitas antara komunitas dan peserta melalui media digital. Hasil pengujian pada penelitian ini menunjukkan bahwa sentralisasi kanal digital meningkatkan keterlibatan pengguna dan kejelasan dalam alur pembelajaran. Serta berkontribusi dalam merumuskan kerangka pendidikan kreatif non-formal berbasis komunitas dan mengembangkan model pembelajaran komunitas yang lebih adaptif, inklusif dan skalabel bagi komunitas seni di Indonesia.</p> <p>Kata kunci: microsite, komunitas online, pendidikan yang inklusif, seni dan desain, dan design thinking</p> <p><b>Abstract</b> <i>Since 2009, Pensil Kertas Community has lived in Bandung city, This community supports inclusive education in design with training programs and collective drawing activities from elementary to out-of-college learners. Major challenges when they hiatus from 2019 to 2024. This paper explores the gap challenges from this communities, process of the finding digital journey through a text-based prototype and digital solutions to help the creative ecosystem in this community. Aligned with the Sustainable Development Goals (SDGs) point 4 (quality education) and 11(sustainable cities), this study adopts a participatory design approach as its design process. Testing phase results this study indicate the centralization of digital channles increases user engagement and enhance clarity in the learning pathways. Furthermore, this study contribute to formulating a framework for community based non-</i></p>

	<i>formal education and developing a more adaptive, inclusive and scalable learning model for art communities in Indonesia.</i>
	<i>Keywords: Microsite, online community, inclusivity of education, art and design, design thinking</i>

## INTRODUCTION

The creative industry is one of the largest economic sectors in the world. The development encompasses the fields of design, music, film, and digital technology. According to UNESCO, this industry provides approximately 50 million jobs globally. To enter this sector, people not only need to be creative, but also need to prepare their education as a key. In reality, creative education is not cheap; formal education always has high tuition fees, especially for individuals from lower economic backgrounds. This inequality emphasizes the importance of inclusive educational approaches that leverage to broaden learning access (Alghazi et al., 2021). In this context, community-based education becomes a viable solution and acts as a bridge between prospective creators and the creative industry, and also reinforces the urgency of inclusive and low-cost learning models as an effective alternative.

The Pensil Kertas Community is one such community that bridges the creative industry with early-stage creators through non-formal education. This community facilitates various art activities and provides fundamental drawing education to new members to become more confident in developing their skills. Since 2009, the community has helped its members to find pathways into the creative industry. This aligns with the Quadruple Helix Innovation Model (Afonso, 2012), which states that the development of the creative industries requires collaboration among four key elements: the government, academia, industry players, and the community. Additionally, within the Society 5.0 framework, communities reinforce a human-centered learning ecosystem that remains relevant by utilizing technology to enhance creativity, productivity, and inclusivity.

From an instructional design perspective, First Principles of Instruction (Merril, 2002), learning sequences, learner-centered engagement, and clear feedback loops must highlight principles for developing non-formal creative learning content in the community. This iterative process, aligned within The Double Diamond framework (Design Council, 2017) provides a divergence and convergence model to support this problem solution model exploration. In the other way, the Jobs-to-Be-Done (JTBD) approach, and text-based prototyping serve a low-fidelity instructional simulation to follow the identified learner goals, to support visualized learning workflows, interactions, and system responses before full implementation (Koponen, 2019). For the non-formal organization, this approach can help to communicate the solution and build the solution systematically without theory-based communication.

In this moment, technology integration plays a central role in strengthening the learning and communication experience. The Technology Acceptance Model (TAM) (Davis, 1989) explains how perceived usefulness and ease of use influence users to adopt digital tools. Key factors Pensil Kertas community is the audience from the beginners to non-design learners, which is the digital interaction not only nurturing the communication of the users, but also how to engage them to get informed and stay with the clarity in every step of learning models. In the community-based based, applying TAM allows the user to get clarity, usability, and perceived value to attach with the system.

Engagement value and the human-centered learning ecosystem are also mentioned In a previous research study from Fathurrahman et al. (2023), who analyzed technological and

communication challenges from Merdeka Belajar Kampus Merdeka (MBKM) student exchange programs. This research shares common indicator variables with the current study, specifically on socio-cultural challenges, communication, and collaboration in adopting learning models. In another research from Sobiruddin et al. (2022), talk about enhancing student competencies through mobile learning or digital, emphasizing pedagogical aspects. This aspect is related to learning method, interactive learning, and the clarity of learning material, which is a main aspect to influences users to accept digital tools to support their learning process. Furthermore, digital learning ecosystem theory from Connectivism (Siemens, 2005) or technology-enhanced learning frameworks (Wang & Hannafin, 2005) suggest that learning is distributed across digital nodes and depends on networked interactions. In the Creative community, social media platforms serve as an entry point and communication hub, while microsites act as a centralized learning node to support the clarity of learning pathways in the community-based.

Despite their strong values in inclusivity, Pensil Kertas Community faces the challenges in sustaining the learning ecosystem after a five-year hiatus (2019-2024). The absence of digital, unclear learning pathways, and limited technology integration creates a gap in finding the best way of accessibility and engagement in community-based learning. Therefore, to preserve the value of togetherness in the community, this research addresses the need to develop a balanced digital approach and a community learning model, critically using a participatory design approach. The study focuses on improving accessibility, interactivity, and engagement for community audiences through the instructional design frameworks, technology acceptance theory, and digital learning ecosystem to support their inclusivity models.

**METHOD**

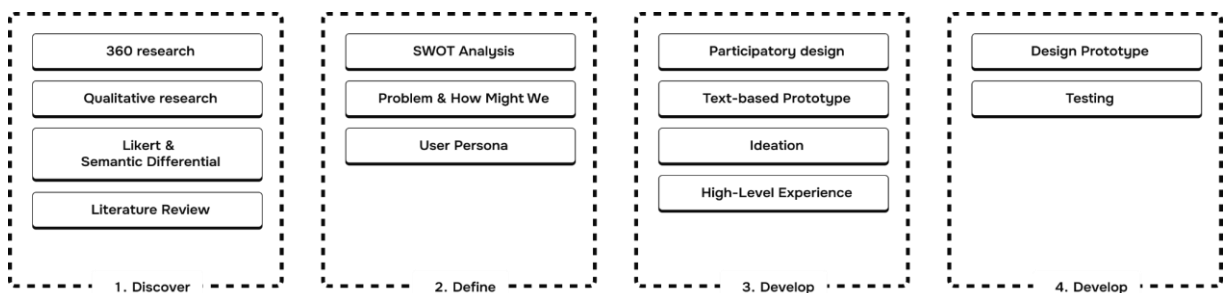


Figure 1. Double Diamond Framework and Mapping Method

In this research, the Double Diamond is not the research method, but the design and development structure to help build of digital solution for this problem statement. This framework divides the design workflow to represent cycles of divergence and convergence phases of each process following Discover, Define, Develop, and Deliver steps. Every step in the framework helps to split each of the research and design methods until prototype evaluation from this solution.

This phase, adopts a qualitative participatory design approach to explore learning challenges, digital needs, and behavioural patterns within the Pensil Kertas Community. Activities on data-collection techniques are as follows:

Table 1. Research method

Method	Details
--------	---------

<b>360° Research and Observation</b>	Observation conduct to documentation backgrounds, profiling member and founder, activity, learning behaviours, until constraints in the current ecosystem.
<b>Qualitative Interviews and Focus Discussions</b>	1 on 1 qualitative interview with the community members to capture learning goals, motivation, pain points, and expectations to join the community.
<b>Likert and Semantic Differential Surveys</b>	Quantitative surveys to assess user perceptions related accessibility, clarity, tech literacy with Technology Acceptance Model (TAM).

To explain how to synthesize the problems and build the raw solution using the text-based prototype to guide the designing process into a usable digital approach prototype. The methods are follows:

Table 2. Design and Development Method

Method	Details
<b>SWOT Analysis</b>	To assess internal and external insight and opportunity from this community
<b>Problem Statement &amp; How-Might-We (HMW)</b>	To support reframing the problems.
<b>User Persona</b>	Fictional personalization development derived from interview and survey findings.
<b>Jobs to-be done</b>	Purposing the research to solve the main task or main problems of this community education.
<b>Text Based Prototype</b>	Low-fidelity instructional design simulation to validate content flow, digital interaction and learner pathways.
<b>Participatory Design</b>	Session involving members in co-ideation
<b>Design Prototype</b>	Building a digital solution prototype to support the goals or JTBD statement
<b>Prototype Evaluation</b>	Evaluation applied mixed-method usability testing combining TAM questionnaires, task-based scenario completion, and short interviews.

## PENSIL KERTAS COMMUNITY

Pensil Kertas in philosophy, represents the fundamental process of an artist when creating art, where everything begins from the pencil and paper. This community is a street art community based on art and design education through various creative activities in Bandung city. This community provides collaboration spaces for young artists and design enthusiasts to learn and develop their skills in art and design. From the fundamental philosophy, this community aims to to build a creative ecosystem that is both educational and inclusive for the public. Whatever the form, it always returns to the concept of thinking that needs to be expressed as the basic illustration of an idea to be developed into a work of art later on, emphasizing simplicity as the root of creativity (*Merdeka.com*, 2015).

This community provides a space for the various individuals' backgrounds for expressing creativity through visual art and design. Some of the works produced within this community include sketches, comics, murals, animations, and handicrafts. Since 2009 members have joined this community with around 400 members, form university students from various

disciplines (design, economics, engineering), as well as elementary school students and professional workers.



Figure 2. Activity Pencil Kertas community.

The activities of this community start from regular live sketch sessions every week at “Balai Kota Bandung” or Car Free Day events in Bandung. And as a monthly event, usually this community does collaboration workshops with other communities. Their target is quarterly the community can build the exhibitions to appreciate the members' activity. These regular activities, active from 2009 until going on hiatus in 2019. The main problems besides the Covid pandemic, which is the regeneration of members. But at the end of 2024, the community began to resume their activities, the community started organizing art workshops held at Hallway Space Bandung. Pencil Kertas aims to create again the ecosystem in art education and inclusivity for a broader audience. This presents also the challenge to expanding accessibility, and maintaining the organization to keep relevant for now after users change their behavior after pandemic and the rapid development of media and technology.



Figure 3. Workshop “How to make a great Character” in Hallway Space

### SWOT Analysis Result

After we gather the observation data and mapping all the points, this results explain the several key points into the following strategic framework about this community (Pencil Kertas).

Table 3. SWOT analysis result.

<b>Strategi SO (Strength - Opportunity)</b>	<ul style="list-style-type: none"> <li>● Develop a digital channel, such as a microsite, social media to reach a wider range of individuals from diverse backgrounds and regions.</li> <li>● Communities need to organize collaborative programs even better with inviting them as speakers or mentors for community learning content.</li> <li>● Beside a digital channel, as the education organization improves, these communities develop micro digital platforms with small maintenance to encourage audiences and centralize information for educational activities online.</li> </ul>
<b>Strategi WO (Weakness - Opportunity)</b>	<ul style="list-style-type: none"> <li>● These communities need to utilize the low-cost tools like canva, figma, notion to facilitate community teaching and training activities.</li> <li>● Other points to develop better quality of education and inclusivity, this organization better get strategic partnerships or collaboration for outreach and open training to get other audiences.</li> <li>● To support the inclusivity, the education curriculum should be flexible to tailored audience interest and individual skill levels.</li> </ul>
<b>Strategi ST (Strength - Threat)</b>	<ul style="list-style-type: none"> <li>● Build a more valuable community with weekly challenges, art exhibitions, and local cultural promotions to strengthen the identity.</li> <li>● Free learning options and the value of the inclusive education from this community, like social media content or downloadable open access content.</li> <li>● Develop a long term roadmap to growth and evolve this community as an educational institution.</li> </ul>
<b>Strategi WT (Weakness - Threat)</b>	<ul style="list-style-type: none"> <li>● Evolving educational institutions need to establish the structure with good divisions to manage all operation aspects in this organization.</li> <li>● Conduct basic training to enhance members capacity to deliver design education from tools, and skill set to adopting new environments.</li> </ul>


This strategic analysis will help the research be narrowed down to one exploratory question for addressing a key issue within this community (How-Might We Method). from the owner perspective,

*“How might we develop the community into a more structured learning ecosystem that is accessible to more people after hiatus 5 years from 2019?”*

With this background problem, the rapid development focuses on strengthening the community to adapt in the new environment, developing the creative infrastructure and reaching a broader audience.

To figure out the minimum viable product or solution of this project, we can focus on the user persona of the current user of this community. This persona builds from the questionnaire responses and feedback about their interest to learn from the community approach.

Table 4. User Persona.

	<p>Rina, a 17-year-old female high school graduate, living in Bandung. She has a strong interest in drawing and wishes to study art more seriously. However, she is unsure where to begin and feels hesitant because she lacks a formal educational background in the arts.</p>
<b>Goals</b>	<ul style="list-style-type: none"> <li>• Build a confidence in her art and design skills</li> <li>• Learn from the community and informal ways</li> <li>• Finding new relationships and creative job opportunities.</li> </ul>
<b>Pain Point</b>	<ul style="list-style-type: none"> <li>• Unsure where to start.</li> <li>• Lack of access to learning materials</li> <li>• Feels insecure and not confident from her art and design skill.</li> </ul>

### Jobs to be Done

Before we determine the digital solution, we can decide the jobs to be done from this user persona, this statement also as an understanding to Pensil Kertas about what a service can a community provide to help users to accomplish their jobs after joining this education program. JTBD frameworks will help to focus the main task we can solve if the community builds the service or solution. The JTBD statement based on the persona as follows:

*“I (Rina) want to develop my artistic skills, build a professional network, and access job opportunities in the creative industry through learning with Pensil Kertas.”*

### Text-based Prototype

A text-based prototype is a low fidelity method to help us to simulate a user interaction with a system rather than a visual interfaces approach. focus on narrative of the user journey, actions, system responses and user feelings on textual format. This method is popular since ChatGPT or AI generative approach text-based output to explain the workflow or journey. Based on the user persona and identify the pain points and opportunities from Rina Persona, the story will start like this:

*“Rina, a 17-year-old from Bandung, was scrolling Instagram. She came across the @pensilkertas account, an art community called Pensil Kerta. A post about a drawing from their members caught her attention. She clicked to see the detailed profile and bio and found a ‘Join Pensil Kertas’ button. Rina was interested to quickly sign up and join their community activities.*

*Through the broadcast group, Rina received a message inviting her to try the Free Course: ‘Introduction to Digital Drawing’ and joined the Weekly Challenge themed ‘Flora Nusantara’. Rina tried to post her artwork following the themes and received lots of feedback from the community. She was interested to dive more into the learning activity and found the ‘Landscape Drawing’ course and enrolled for a one-month in-studio learning program.*

*During her time at the studio, Rina learned techniques from experienced mentors. She gets more motivated and skillful after 3 weeks of learning in the hallway space. In the final week, her mentor encouraged her to join the Final Challenge. Collaboration with the animation studio from Bandung city, to looking the new member of illustrator to join. Rina applied and took part in the last design challenge. Through hard work, she passed the test and was overjoyed!*

*Rina completed the course, received her certificate, and officially joined the studio as a new illustrator. Rina didn't forget and is still active in the broadcast channel to find out the new challenge, new course and looking at the Pensil Kertas Merch Shop, where she bought a sketchbook and a cool T-shirt as a loyalty of her creative journey through the community."*

From this story we can finding the several programs or features were selected as the most relevant and essential to support this community digital platform :

- Centralize social media, as a hub and broadcast channel
- Microsite to gather the call to action, registration, course library and community artwork gallery
- Broadcast channel to centralize the communication of this community to their members.

## Digital Platform Prototype

After we mapping the journey and features from the text-based prototype, we tried to document the brand identity, graphic and the atomic level to use as a component to support building this system. applying the Atomic Design System approach, to help build the structure of the user interface in a modular manner, starting from the smallest elements to the most complex components.

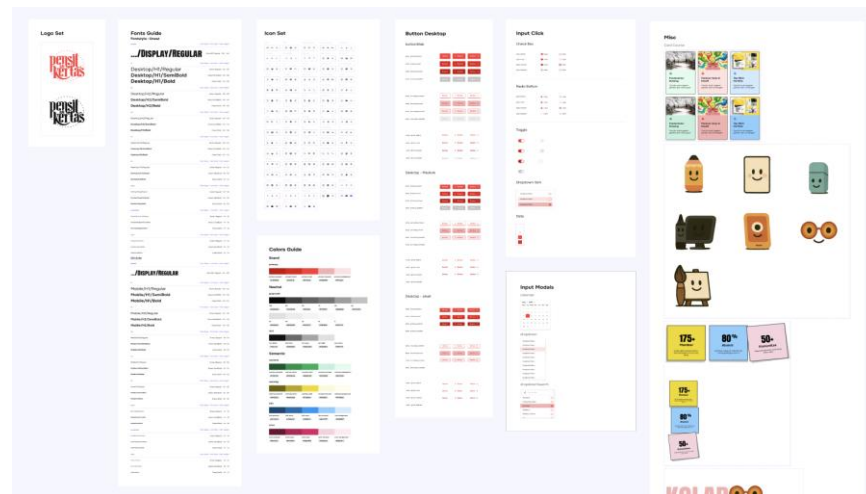


Figure 4. Atoms (Color, Typography, Icons, Logo, Illustration), Molecules (Button, Input Field, Checkbox, etc.)

The page was then designed as a microsite, structured to present information based on the previously identified feature priorities. This page serves as the prototype link that will be validated with users.

Table 4. Link prototype.


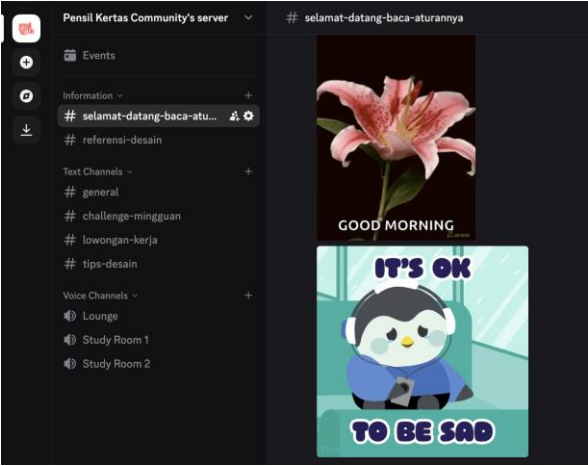
<a href="#">Link prototype desktop</a>	<a href="#">Link prototype mobile</a>
	

Figure 5. Mockup page microsite(left) dan community online channel discord (right)

## Testing

Testing phase as a part of delivering the system before launch and developing in real time to gather feedback from the matched persona and characteristic. We tried to find out the comparison based on the text-based prototype to the real interaction from the users. This testing was conducted with eight respondents.

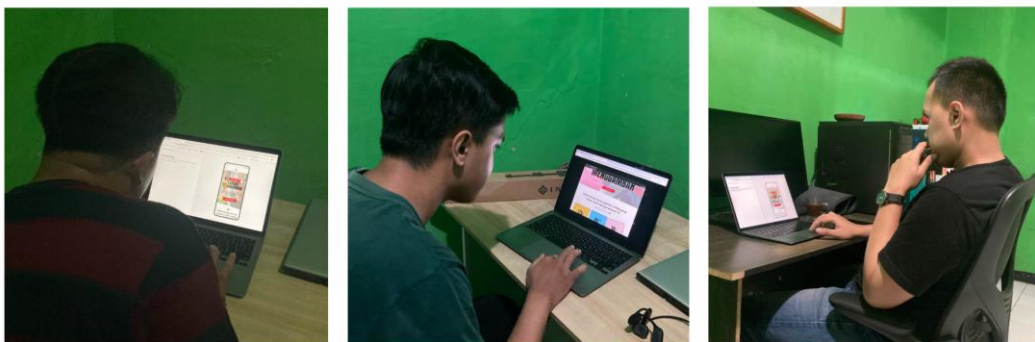


Figure 6. Live testing of the microsite page with respondents.

## DISCUSSION

The findings of this research extend beyond identifying operational education activity challenges within the Pensil Kertas Community, and also provide insight into how community-based organizations can adopt technology to support their value in inclusivity and learning ecosystems. Data from interviews, surveys and prototype testing indicate that accessibility, clarity, and digital communication are the central barriers preventing learners and beginners from fully engaging with non-formal creative education.

### Relation to Instructional Design Frameworks

The results show that learners need structured guidance before they gain confidence to explore creative skills. This aligns with First Principles of Instruction (Merril, 2002), problem

centered learning and activation is the priority of knowledge and clear guidance. The text-based prototype used as a low-fidelity instructional simulation, effectively translates these principles into practical workflows. The journey allowed learners to visualize step by step activity and receive clear expectations before engaging with actual programs.

Furthermore, the iterative process in the Double Diamond reflects how community learning needs continuous insight validation, synthesis, and refinement solutions. Data indicates, users respond positively when instructional content is broken into simplified steps, this confirms the suitability of this framework (double diamond) for non-formal creative learning education.

### **Alignment with Technology Integration Theories**

Survey responses, learners willingness to adopt the microsite is influenced by two factors:

- Perceive usefulness, users felt the centralized platform made it easier to locate courses, challenge, and information.
- Perceived ease of use, users appreciated the simple, linear architecture of the microsite.

These findings confirm that the community digital approach lowers cognitive barriers and increases technology adoption for beginner level learners. Similar to Sobiruddin et al. (2022), who found mobile platform learning increased student competency through clarity of the materials, this study also shows clear structured digital pathways to strengthen learner engagement and motivation.

### **Relation to Inclusivity of Education Models and Community-based Learning**

The persona and JTBD analysis highlight learners from informal backgrounds require learning models that are low-cost, inclusive and flexible. This align with:

- Quadruple Helix Innovation model, about emphasizing collaboration between community, educators, industry, and government.
- Society 5.0, human-centered technology supports education accessibility and inclusivity.

Microsite and social media as a hub for Pensil Kertas community, enhance the position to be a wider learning network supporting Siemens Connectivism theory about learning is distributed across digital networks and collaborative interaction. Also these findings related with Fathurrahman et al. (2023), socio-cultural and communication appears as a similar barrier in the community learning, digital centralization approach help reduce these gaps with improving the flow of information and clarity of expectations across community members.

### **Implications for Educational Technology**

This research contributes three key implications:

Table 5. Research Implications and Contributions

1. <b>Digital centralization is critical for non-formal learning ecosystems.</b>	Microsite as a learning hub, offering structure and clarity for learners otherwise rely on fragmented social media posts
2. <b>Text-based prototyping can serve an effective early-stage method for educational design.</b>	It is lower development costs, simplifies communication among stakeholders and ensure early validation of user needs

**3. Community-based can scale up the value by integrating simple technology tools.**

Unlike large institutional systems, communities can deploy low-barrier solutions like microsite, broadcast channels to maximize reach and engagement.

## CONCLUSION

The result serves two main challenges faced by the Pensil Kertas community, which is the lack of digital visibility and the limited accessibility. But in other ways the main concept of this solution is not the digitalization, but how this education approach can be still relevant and operate in this moment. This approach should reinforce this sense of inclusivity. Some of the points like optimizing the QR code feature, refining the user flow within discussion, curation, and feedback forums for active members, strengthening social media engagement, and developing a curriculum structure to support non-formal learning activities, will supports to enhance the real journey need to define and enhance how user interact with the system, also severals points is how the technology can support this inclusivity to keep relevant.

Moreover, text-based prototyping can provide a practical and low-barrier for designers to explore, iterate and communicate the solution ideas effectively. This method enables design and community members to collaboratively define user experience before implementation.

## REFERENCES

- Booth, A., Sutton, A., & Papaioannou, D. (2016). *Systematic approaches to a successful literature review* (2nd ed.). SAGE Publications.
- Brown, T. (2019). *Change by design: How design thinking transforms organizations and inspires innovation*. Harper Collins.
- Chen, J., Zhang, X., Wang, L., & Li, P. (2021). Natural language processing in education: Potentials and challenges. *Journal of Artificial Intelligence Research*, 68(4), 257–280. <https://doi.org/10.1613/jair.1.12345>
- Cooper, H., Hedges, L. V., & Valentine, J. C. (Eds.). (2019). *The handbook of research synthesis and meta-analysis* (3rd ed.). Russell Sage Foundation.
- Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). SAGE Publications.
- Design Council. (2017). *The design process: What is the Double Diamond?* <https://www.designcouncil.org.uk/news-opinion/design-process-what-double-diamond>
- Ezzaim, A., Kharroubi, F., Dahbi, A., Aqqal, A., & Haidine, A. (2022). Artificial intelligence in education – State of the art. *International Journal of Research and Analytical Reviews*, 5(6). <https://www.ijceds.com/ijceds/article/view/37/12>
- Fathurrahman, M., Ansori, I., Yulianto, S., Widodo, S. T., Irvan, M. F., Krisnawati, D., Pristiwanto, R., & Lestari, J. T. (2023). Implementation of the Freedom Learning Program for prospective primary school teachers at Universitas Negeri Semarang: Opportunities and challenges. *Edcomtech: Jurnal Kajian Teknologi Pendidikan*, 8(1), 1–11. <https://doi.org/10.17977/um039v8i12023p1>
- Gibbons, M. (2000). Mode 2 society and the emergence of context-sensitive science. *Science and Public Policy*, 27(3), 159–163. <https://doi.org/10.3152/147154300781782011>

- Knapp, J., Zeratsky, J., & Kowitz, B. (2016). *Sprint: How to solve big problems and test new ideas in just five days*. Simon & Schuster.
- Koponen, T. (2019). *Strategic Writing for UX: Drive Engagement, Conversion, and Retention with Every Word*. Sebastopol, CA: O'Reilly Media.
- Koesoemadinata, M. I. P. (2024, Oktober). Definisi desain, posisi dan klasifikasi dalam bidang seni rupa [Slide presentasi]. Disampaikan di kelas, Bandung.
- Koesoemadinata, M. I. P. (2024, Oktober). Inovasi, dan transformasi kebudayaan [Slide presentasi]. Disampaikan di kelas, Bandung.
- Plattner, H., Meinel, C., & Leifer, L. (Eds.). (2010). *Design thinking: Understand – improve – apply*. Springer. <https://doi.org/10.1007/978-3-642-13757-0>
- Prasetyo, A., & Santoso, B. (2021). Pengembangan platform e-learning untuk pendidikan akademik di Indonesia. *Jurnal Teknologi Pendidikan*, 23(2), 45–60. <https://doi.org/10.1234/jtp.v23i2.5678>
- Soewardikoen, D. W. (2020). *Metodologi penelitian desain komunikasi visual (Edisi revisi)*. Kanisius.
- Tranfield, D., Denyer, D., & Smart, P. (2003). Towards a methodology for developing evidence-informed management knowledge by means of systematic review. *British Journal of Management*, 14(3), 207–222. <https://doi.org/10.1111/1467-8551.00375>
- UNESCO. (2020). *Global education monitoring report 2020: Inclusion and education*. UNESCO.
- Wang, F., & Hannafin, M. J. (2005). Design-based research and technology-enhanced learning environments. *Educational Technology Research and Development*, 53(4), 5–23. <https://doi.org/10.1007/BF02504682>
- Xu, Z. (2022). *AI in education: Enhancing learning experiences and student outcomes*. ResearchGate. [https://www.researchgate.net/publication/379259445\\_AI\\_in\\_education\\_Enhancing\\_learning\\_experiences\\_and\\_student\\_outcomes](https://www.researchgate.net/publication/379259445_AI_in_education_Enhancing_learning_experiences_and_student_outcomes)