Digital Project-Based Learning for Kids: A Case Study of Start-up Kids Campus

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Abstract—This paper proposes a conceptual model for implementation of Digital Project-based Learning (D-PBL) for kids in the age range of 7 to 17 years old to teach them 21st century skills using project-based learning methodology in a digital environment. The model is applied to a practical initiative called Start-up Kids Campus which focuses on fostering start-up and entrepreneurship skills, creative economy, and development of soft skills. Kids living in different regions, but who have the same country origin are brought together in a D-PBL platform to collaboratively participate in impactful projects. The paper discusses the conceptual model and shares the experiences gained from the initial work and the digital tools and resources used for the implementation of D-PBL in the context of Start-up Kids Campus. Future works include integration of kid friendly project management tools, expanding the access to multi-national teams, and integration with generative AI solutions.

Keywords - digital project-based learning, start-up kids, soft skills, knowledge economy, creative economy

I. INTRODUCTION

Project-Based Learning (PBL) is an educational approach that emphasizes the acquisition of knowledge through the solving of real-world problems and participation in projects [1]. PBL is a constructivist theory-based learning model that involves students in problem-solving activities and gives them the chance to work in teams autonomously to construct their own learning in accordance with the demands of the curriculum. PBL is an innovative learning model that involves students in problem-solving activities and gives them the chance to work in teams autonomously to construct their own learning in accordance with the demands of the curriculum [2]. It is a student-centered learning approach that offers educators the opportunity to engage learners in solving complex real-world problems [3]. PBL has also been found to improve students' performance and achievement and has been used in various fields of education, including STEM education [4] [5], vocational education [6], and engineering education [7]. The implementation and assessment methods of PBL makes it a bit challenging [8][9]. In general, PBL involves working in groups, developing technical and communication skills, excelling in creative and critical thinking, which can be enhanced by digital educational technologies.

Digital Project-based Learning (D-PBL) is an innovative approach to education that incorporates digital technologies and tools to facilitate learning and enhance the quality of education [10]. D-PBL extends the traditional approach to PBL by incorporating digital technologies and tools to facilitate learning and has been shown to improve the learning outcomes of students and enhance the quality of education and developing variety of skills [11].

This paper proposes a conceptual model for D-PBL for kids, which is inspired by the play-based Finish educational framework in primary education and the Erasmus+'s D-PBL project in higher education [12]. The Finnish education system is known for its play-based educational framework, which emphasizes the importance of learning through play and exploration [13]. The Finnish curriculum is designed to promote creativity, critical thinking, and problem-solving skills. The benefits of the Finnish curriculum include high academic achievement, low levels of stress and anxiety among students, and a focus on equity and equality in education [14]. On the other hand, the Erasmus+ program has been involved in several projects related to project-based learning and digital technologies which demonstrate the potential benefits of project-based learning and digital technologies in various fields and learning contexts [15][16][17]. The recent Erasmus+ D-PBL project, however, aims to provide learners with technical skills in a real-world context, develop digital competencies that are useful in business, and involve students in multinational teams. In a similar approach, the model D-PBL for Kids is applied to a practical initiative called Start-up Kids Campus, which aims to teach kids in the age range of 7 to 17 years old various 21st century skills, including start-up and business skills, knowledge and creative economy, soft skills, and emotional intelligence by engaging young students in project-based extracurricular courses and special events empowered by digital learning environment. The initiative fosters cross-regional collaboration among kids in different parts of the world, but who have the same country origin. The kids supported by their parents and remote mentors work together in a digital learning environment and participate in projects to solve real-world problems affecting their community. The paper discusses the theoretical foundations of the conceptual model, the design principles, the learning outcomes,

and how D-PBL is being implemented in the Start-up Kids Campus initiative. The findings of this paper have implications for the education of kids, particularly in the digital age, and offer insights for future research directions.

In theory, D-PBL, which follows student-centered learning approach brings an immense opportunity to enhance formal education by engaging learners in solving complex real-world problems using digital tools and resources in various fields of education, including STEM education, vocational education, and engineering education. However, its applicability and implementation can be challenging due to the need for a shift in pedagogical approaches and the lack of resources and support from trained teachers [18][19]. Most tools, settings, environments, and resources for project-based learning are designed to support the interaction of small groups rather than entire classes, making them particularly unusable in classroom settings [20]. However, well curated digital technologies and teachers with digital competencies can provide opportunities to overcome these challenges in an extracurricular setting at a satisfactory scale. Digital tools such as video production resources, editing software, 3D design platforms, coding, e-book writing, and role-play resources can be used to enhance student engagement and provide a more authentic learning experience [21]. Additionally, the use of flipped teaching, active learning, and collaborative active learning digital spaces can be used to facilitate multidisciplinary and multinational project-based learning [22].

In the case of Start-up Kids Campus, D-PBL model was implemented based on basic and generic learning competences and project-based courses were designed to advance learners start-up and business skills and these courses were offered via integrated digital learning environment. Unlike the highly hyped self-paced learning [23], which offers limited or no opportunity for collaboration and is prone to procrastination, cohort-based traditional learning is a better option for implementation of the PBL methodology. This paper discusses a conceptual model that facilitates a project-based digital learning approach to teach kids start-up and business skills. Courses are offered at clearly specified schedules and in addition to pre-recoded online learning materials, live sessions are arranged at regular time intervals.

The rest of the paper is organized as follows: section II discusses literature review, section III discusses the D-PBL for Kids conceptual model, section IV highlights the implementation of D-PBL in Start-up Kids Campus, section V presents some experiences and lessons learned, and section VI concludes with summary of findings and future directions.

II. LITERATURE REVIEW

Project-Based Learning (PBL) is an educational approach that emphasizes the acquisition of knowledge through the solving of real-world problems and participation in projects [2]. PBL is a constructivist theory-based learning model that involves students in problem-solving activities and gives them the chance to work in teams autonomously to construct their own learning in accordance with the demands of the curriculum [24]. It is an innovative learning model that involves students in problem-solving activities and gives them the chance to work in teams autonomously to construct their own learning in accordance with the demands of the curriculum. Implementation of PBL can be made for different purposes and at different success rates. This section briefly discusses implementation experiences of both PBL and D-PBL and some of the related challenges [8].

A project-based learning in the classroom was studied by [17], in which 114 fist-year high school students participated with the objective to analyze the experience of the students who participated and understand their satisfaction. A very positive assessment was made by the students, related to teamwork and the use of digital tools as explained by the results obtained. However, there were complications regarding the time devoted and the orientation during the project work. The authors have analysed groups using inferential analysis and have revealed significant differences between the work groups.

In another study [25], the authors investigated the effects of D-PBL on students' academic achievement and technological skills. It was found that a significant difference exists between students' academic achievement who were taught under the D-PBL with satisfactory results and students who were taught under non-PBL courses which didn't meet expectations in their results.

A research study conducted by [12], in the higher education sector aimed to explore how students cope with a digital project-based learning environment and how the findings can be utilized to enhance future digital or blended-learning situations. The evaluation of a higher education course involved students conducting an independent empirical study through self-directed project planning, execution, and critical reflection. The study focused on the evaluation results of a digital project-based course in higher education. The research findings centered on the students' perspectives, behaviours, and inclinations towards digital project-based learning.

Researches similar to our approach were done at different capacities. For instance, [26], reviewed the pedagogical structure and the impact on skill development of live marketing related courses designed using project-based methodology, but at a university setting. The courses that were conducted in real-time aimed to assist students in acquiring technical skills related to digital marketing, as well as essential meta-skills such as creativity, critical thinking, collaboration, and communication. The assessment process, which included both direct and indirect methods, was used to evaluate the effectiveness of the projects. The results indicate that live project-based learning can aid in the development of technical and meta-skills that are crucial for students to adapt to uncertain and ambiguous situa-

tions, and to be well-prepared for the workforce.

Sampurna, et al. [27], explored learners' and teacher's participation in online non-formal project-based language learning. Tinapple, et al. [28], outlined a project-based digital arts curriculum through which novice middle and high school students are intrinsically motivated to learn and apply STEM skills and computational thinking. In another study, Hana and colleagues [29], examined the potentials of digital and physical modeling as tools for project-based learning. Marry Rose, et al. [30], suggested that crafting digitized modules in the context of project-based learning can be an effective tool in improving learners' scientific competency skills. To empower children and young people with creative and critical digital skills [31], a knowledge and skill set base was developed and learning was suggested to be offered through playful solutions. In another study [32], the use of digital storytelling for early childhood creativity was explored. Johnston, K. in [33], discussed how digital technology can support children and educators as co-learners.

The study papers discussed in the literature offered theory and practice-based guidelines for practitioners who wish to empower children to make and shape digital technology in the context of non-formal learning and fab labs. These studies and related resources demonstrate the potential of D-PBL to empower skills and talent development in kids at variety of age ranges. However, these studies do not offer a clear conceptual model that can be replicated for a selected age ranges and for specific competency areas. Building on these studies, the Start-up Kids Campus initiative designs a conceptual model for implementing D-PBL for kids with the objective to teach kids start-up and business skills along with technical skills, soft skills and emotional intelligence as a form of extracurricular cohort-based courses, events and projects.

III. DIGITAL PROJECT-BASED LEARNING FOR KIDS CONCEPTUAL MODEL

The conceptual model for implementing D-PBL for Kids in the case of Start-up Kids Campus revolves around these three complementary phases:

- *Basic and generic competences*: indentifying and documenting basic and generic competencies desired to be mastered by kids of age ranging from 7 to 17 years old.
- *D-PBL Courses:* Designing and categorizing digital courses that teaches kids start-up and business skills, technical skills, soft skills and emotional intelligence coupled with the competences identified in a project-based learning setup
- *Educational digital technologies*: selection, design, development, integration and utilization of digital technologies used to disseminate the D-PBL courses, which in turn embed the desired competences.

A. Basic And Generic Competences

The competences that are used in this project are categorized into two categories and their brief descriptions are included wherever possible:

1. *Basic competences:* These competences include
   a. *Literacy;*
   b. Numeracy;
   c. Information and Communication Technology;
   d. Citizenship, Language, Culture, and Nationality,;
   e. Entrepreneurship and Start-up skills;
   f. Science and Technology;
   g. Communication in an International language.
2. *Generic competences for PBL*: These competences include
   a. *Critical thinking and problem-solving*: Project-based learning motivates children to scrutinize intricate problems, exercise critical thinking, and devise inventive solutions. They acquire the ability to recognize obstacles, generate ideas, and assess various methods to tackle problems [34].
   b. Communication and collaboration: Engaging in project-based learning cultivates effective communication and collaboration skills in children. They acquire the skills to articulate their thoughts, actively listen to others, negotiate, and work collaboratively as a team. They also develop the ability to delegate tasks, collaborate, and make valuable contributions to group projects.
   c. Creativity and innovation: project-based learning provides children with the freedom to explore ideas, experiment with solutions, and think creatively, which stimulates innovation. They learn to embrace diverse perspectives, take risks, and develop original solutions [35].
   d. Digital literacy and technology skills: Participating in digital project-based learning provides children with crucial digital literacy skills. They acquire the ability to navigate digital tools and platforms, utilize technology for research and communication, and develop expertise in using software and online resources that are pertinent to their projects [36].
   e. *Time management, productivity and organization:* Project-based learning teaches kids valuable skills in time management, organization, and prioritization. They learn to set deadlines, create schedules, and manage their time effectively to complete tasks within given timeframes.
   f. *Self-directed learning and autonomy*: Project-based learning enables children to take charge of their learning process [37]. They acquire self-directed learning skills, become more independent in their decision-making, and assume accountability for setting objectives, strategizing, and tracking their advancement.

B. D-PBL Courses

Some of the courses designed for the purpose of implementing D-PBL for Kids for start-up and buisness skills include:

- Entrepreneurship for Kids
- Start-up and Business Development
- Nationality, Language and Culture
- Coding for Kids
- 3D Design and Printing for kids
- ICT Literacy
- Math Mastery and
- Environment and Sustainability

All these courses are offered in an online environment, enrolment per class is in small number from five to seven students. The courses are time bound and scheduled with interval live sessions.

C. Educational digital technologies

There are a range of digital technologies compatible with teaching programs for kids. However, in the case of Start-up Kids project, the technology resources are highly curated and well-integrated. Some of the tools are:

a. Smart LMS: a freely available and open-source leanring management system customized into Smart LMS, which is the core system for the Start-up Kids virtual campus platform.
b. Video conferencing tool: Well-integrated with the Smart LMS, the online meeting and video conferencing tool is used to organize cohort-based online live session with students.
c. Media content creation: Digital tools to create, edit, and publish digital content.
d. 3D design and Coding tools: For prepating 3D printed educational and useful to the day-to-day life of students.
e. Project Management and Calendar tools: These tools and resources are crucial to the project-based learning methodology.
f. Virtual/Augmented Reality (VR) resources: Used to simulate and experince digital worlds.
g. Productivity and Communication tools: used to inpire kids to start working in a productive manner.

D. The D-PBL Conceptual Model

The following figure illustrates the conceptual model of the D-PBL for kids project implementation in Start-up Kids Campus:

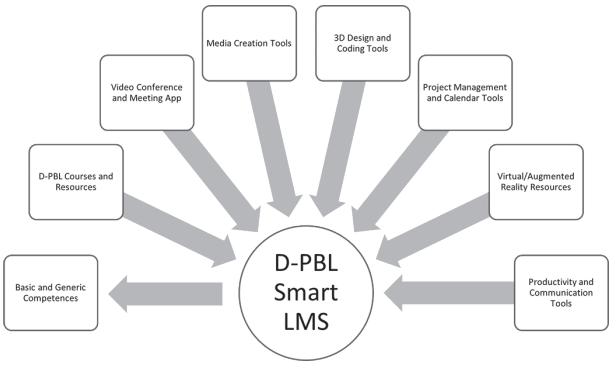

Fig. 1. D-PBL for Kids Conceptual Model

All the tools and resources around the D-PBL Smart LMS contribute to the development of the basic and generic competences. At the center of the simple conceptual model is the core digital technology for integrating with other supplimentary tools and resources. The use of digital technologies has a significant effect on project-based learning for children, resulting in various advantages, including:

- *Access to information and resources*: Children can benefit from digital tools and technologies as they provide them with access to a wide range of information resources, including online libraries, educational websites, and research materials. This enables them to explore different perspectives, gather information, and enhance their comprehension of project subjects.
- *Collaboration and communication*: With the aid of digital platforms, children can collaborate and communicate with ease, irrespective of their location. They can connect, exchange ideas, work together on projects, and receive immediate feedback from both peers and mentors.
- *Multimedia and interactive learning*: The use of digital technologies provides children with multimedia resources, such as interactive simulations, videos, and virtual reality experiences. These resources increase engagement, offer practical learning opportunities, and simplify complex concepts, making them more enjoyable and accessible for kids.
- *Project management and organization*: Children can utilize digital project management tools to effectively organize their tasks, set deadlines, track progress, and collaborate with team members. These tools offer intuitive platforms that enable them to visualize their project workflow, allocate resources, and manage their work efficiently.

Taking into account the aforementioned factors, a conceptual model for introducing project-based learning in a digital learning setting to teach children start-up and business skills, technical skills, soft skills, and emotional intelligence may comprise the subsequent elements:

1. *Project Selection and Planning*: Children, under the guidance of teachers or mentors, select project subjects that align with their interests, learning objectives, and desired competencies. They strategize the project's scope, goals, and outcomes, taking into account the incorporation of start-up and business skills, technical

skills, soft skills, and emotional intelligence.

2. *Digital Resource Exploration*: Children employ digital resources and tools to conduct research, collect information, and investigate pertinent content. They utilize online libraries, multimedia resources, educational websites, and interactive platforms to attain comprehensive and captivating learning experiences.
3. *Collaboration and Communication*: Digital platforms enable virtual collaboration and communication among children, peers, and mentors. They participate in online discussions, brainstorming sessions, and peer feedback to promote efficient teamwork, communication abilities, and cross-cultural comprehension.
4. *Skill Development Activities*: Children take part in diverse activities that aim to enhance particular skills. They involve themselves in online courses, interactive tutorials, virtual workshops, and practical projects that concentrate on developing start-up and business skills, technical skills, soft skills, and emotional intelligence.
5. *Project Implementation and Reflection*: Children utilize their gained knowledge and skills to strategize, implement, and finalize their projects. They make use of digital project management tools to arrange tasks, establish deadlines, monitor progress, and cooperate with team members.
6. *Assessment and Feedback*: To assess children's project outcomes and their progress in achieving targeted competencies, evaluation techniques such as rubrics, peer evaluations, and self-reflection are employed. Teachers and mentors offer constructive feedback to facilitate continuous improvement and learning.
7. *Reflection and Presentation*: Children contemplate on their project experiences, acquired knowledge, encountered obstacles, and individual development. They exhibit their project results through presentations, digital portfolios, or multimedia artifacts to showcase their accomplishments and improve their communication abilities.
8. *Continuous Learning and Iteration*: The model highlights the significance of continuous learning and iteration, enabling children to participate in several project cycles to improve their skills, knowledge, and competencies. Feedback obtained from assessments and reflections is utilized to inform subsequent projects, fostering a progressive and iterative learning process.

The implementation of this model enables digital project-based learning to offer a well-organized and captivating approach for children to enhance their start-up and business skills, technical skills, soft skills, and emotional intelligence in a digital learning setting. The model encourages active learning, collaboration, critical thinking, and creativity, empowering children with the competencies required for success in the 21st century.

IV. IMPLEMENTATION OF D-PBL FOR START-UP KIDS CAMPUS

The D-PBL for Kids concept model was implemented partially in the Start-up Kids Campus initiative. The initiative is founded in Kigali, Rwanda, but targets kids of Eritrean communities living all over the world with the mission to bring together kids having different cultural, educational, and life exposures, yet who have the same country origin. As of this writing, the initiative so far attracted 68 students age ranging from 7 to 17 years old who are living in Africa, Europe, UK, and US. Out of which 37 students are able to participate in the core digital project-based learning platform – the Smart LMS. While all of the students are active participants of one or more digital tools, especially the online video conferencing tool is very popular.

To implement the project, first the desired basic and generic competences were identified. Following, D-PBL courses were developed and/or adopted and customized from popular public resources. Finally, the relevant digital educational technologies were selected, customized and deployed. Discussed below is the details for the implementation of the D-PBL technical platform followed by PBL course delivery and translating learning into the basic and generic competencies identified in section III.

A. Implementation of Smart LMS

On of the key components for the implementation of the D-PBL conceptual model for the Start-up Kids Campus initiative is the digital learning platform called as Smart LMS. The purpose of Smart LMS is to deliver project-based learning courses and manage student teams and related projects. Smart LMS is developed based on an open-source content management system – WordPress, customized and rebranded as Smart LMS. Here are the main components of the LMS in support of D-PBL:

- *Smart Lessons and Quizzes* – this component enables teachers and mentors to prepare time-bound, pre-scheduled learning and assessment materials.
- *Smart Teams* – adds the ability to create teams of size from five to seven members. Members discuss about the course they are taking, project they are working on and share knowledge with other students in the platform.
- *Cohort-based learning* – instead of leaning at their own pace, students participate in PBL courses within a pre-defined time range, encouraging them to submit assignments, project milestones in a given time period.
- *Content Drip* – this is more of a feature than a component. Series of learning contents are delivered at specific dates of the week and are made available once the previous lesson is completed.
- *Multi teachers/ Mentors* – a single project-based course is facilitated by multiple teachers/ mentors who specializes in different professions that are related to the particular project-based courses.
- *Video conference integration* – students are able to participate course-related pre-scheduled online classes which run in the form of workshops. This is made possible by integrating video conference tools like Google meet and Zoom meeting.

- *Basic project and time management* – students are able to access platform wide calendar with a view of all project and course-related upcoming and past events. In the future, kid-friendly project management tools will be introduced

B. Course Deisgn and Delivery

Project-based courses are designed and delivered via the Smart LMS platform. Courses are meant to teach young students start-up and business skills in an engaging and participatory way. Some of the courses already applied are:

- Start-up and Entrepreneurship for kids
- Communication, Language, and Culture
- Basic Finance for kids
- 3D Design and Printing
- Coding and Game Development
- Technology, Toys and Kids
- Creative Economy
- Soft skills for Kids

C. Ocassional Events, Workshops and Hackathons

As part of the Start-up Kids Campus initiative, teachers and mentors organize competitive events, workshops and hackathons for young students while educating them start-up skills and business concepts.

V. EXPERIENCES AND LESSONS LEARNED

Although the implementation of D-PBL for Kids for the Start-up Kids Campus initiative is at its initial stage, the following lessons were learned from the experience:

- Project-based learning is becoming more attractive and engaging to young students as it is enhanced by digital technologies
- Interactive live sessions and gamified contents gets more attention by students
- Allocating students into teams and providing them with similar projects leads to competition and cooperation and students learn new concepts in their way
- Too much pre-recoded video, audio and text materials are a bit boarding to students and many students collect their attention when team members trigger each other
- Students learn better and achieve better if they are supported and guided by mentors
- As the age increases, the seriousness of the project selected and accomplished by students increase
- Start-up and business skills can be taught to children of as low as six to seven years old.
- Some parents have limited technological exposure, especially those living in Africa and new immigrants in Europe and become bottle neck for their children in using technology enhanced learning
- As technology gets advanced, especially with the introduction of generative AI, students will get the opportunity to utilize AI as mentors in the D-PBL settings.

VI. CONCLUSION THE FUTURE PLANS

To conclude, the implementation of digital project-based learning provides a promising approach for teaching children start-up and business skills, technical skills, soft skills, and emotional intelligence. The conceptual model presented above offers a framework to guide educators, mentors, and parents in promoting the holistic development of children in a digital learning environment.

Looking forward, there are exciting possibilities for enhancing the educational experience further by integrating generative AI technologies. By leveraging generative AI, D-PBL can be personalized and adapt learning materials to cater to the unique needs and interests of individual children. AI algorithms can analyze student performance data, identify areas for improvement, and suggest tailored resources, exercises, or challenges to optimize their learning journey.

Moreover, generative AI can facilitate the creation of interactive and immersive learning experiences. Virtual reality (VR) and augmented reality (AR) applications can simulate real-world scenarios, enhancing engagement and understanding. For instance, children can explore virtual start-up environments, participate in business simulations, or collaborate with AI-driven virtual agents as project partners or mentors.

Additionally, the use of generative AI can enable intelligent feedback and assessment systems, complementing the lack of enough mentors and lack of parents' attention to their children. Natural language processing algorithms can provide real-time feedback on written and verbal communication skills, helping children refine their abilities. AI-powered assessment tools can analyze project outputs, evaluating not only the final results but also the process, critical thinking, and problem-solving skills demonstrated throughout the project.

To ensure the ethical and responsible use of generative AI in teaching children, it is crucial to address privacy concerns, algorithmic biases, and maintain a human-centered approach. Ongoing research and collaboration between AI developers, educational experts, and child psychologists are essential for designing AI systems that align with pedagogical principles, promote inclusivity, and prioritize the well-being of children.

In the future, the integration of generative AI technologies within the framework of digital project-based learning has the potential to revolutionize how children acquire and apply essential skills. It will enable personalized, immersive, and intelligent learning experiences, empowering children to develop the competencies required for success in a rapidly evolving world.

By embracing these future development ideas and fostering a culture of innovation and collaboration, a dynamic and engaging learning environment can be created that nurtures the growth and potential of every child.

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