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Empowering Teachers' Learning to Enhance Students into 21st-Century Learners

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Abstract

This research endeavor is centered on creating a comprehensive online self-training program to enhance educators' understanding of the essential characteristics of 21st Century Learners. The program is thoughtfully designed with two principal components: the first focuses on equipping teachers with the necessary skills and strategies to foster and nurture their students as 21st Century Learners effectively. In contrast, the second component provides educators with practical guidance on implementing these newly acquired skills in real classroom settings. The study employed a five-step Research and Development methodology to ensure a rigorous and systematic approach, culminating in a structured one-group pretest-posttest design. This design was executed in a randomly selected school, engaging a cohort of eight dedicated teachers and 121 diverse students who participated in the program. This research revealed that the "Online Self-Training Program for Empowering Teachers to Strengthen Their Students as 21st Century Learners" met and exceeded the established research criteria. Consequently, the program holds significant promise for broader application and implementation across schools nationwide, ultimately contributing to enhancing educational practices in alignment with the demands of the 21st Century.

Keywords: empowering teachers, learning of teachers, 21st century learners, teachers strengthening students

1. Introduction

1.1 Significance of the Research Problem: Empowering Teachers' Learning to Enhance Students as 21st Century Learners

The landscape of education is rapidly evolving, necessitating innovative approaches to teaching and learning that prepare students for the complexities of the 21st Century. As globalization, technology, and the information revolution transform how knowledge is created and shared, it becomes essential for educators to equip students with skills that extend beyond traditional academic success. This research focuses on empowering teachers to enhance student learning through educational innovations, explicitly targeting the development of 21st-century learners. Understanding the significance of this research problem involves exploring its impact on educational practices, teacher professional development, and student outcomes.

1.1.1 The Imperative of 21st Century Skills

The 21st Century Skills Framework, articulated by organizations such as the Partnership for 21st Century Learning (P21), emphasizes students' need to develop critical thinking, collaboration, communication, and creativity (P21, 2019). These skills are essential in navigating an increasingly complex world where adaptability and problem-solving are invaluable. We address a crucial gap in educational practice by focusing research on how educators can be empowered to foster these skills. Empowering teachers through professional development initiatives helps them create learning environments responsive to students' needs and conducive to developing these essential skills (Voogt & Roblin, 2012).

1.1.2 The Role of Teachers in Modern Education

Teachers serve as pivotal agents of change within the educational system. In the context of modern education, their roles are evolving from mere knowledge transmitters to facilitators of learning experiences that prepare students for a dynamic future. Research indicates that empowered teachers engaged in continuous professional

development are better equipped to utilize innovative teaching methods and technologies (Desimone, 2009). By focusing on empowering teachers, this research highlights the importance of shifting educational paradigms that recognize educators' transformative role in shaping student experiences.

1.1.3 Challenges of Teaching in the 21st Century

Teaching in the 21st Century is fraught with challenges, including the rapid advancement of technology, diverse classroom populations, and an ever-changing curriculum. These challenges require educators to be adaptable and agile in their teaching practices. This research problem is significant because it seeks to identify and address these challenges through teacher empowerment and professional development. Educators need support transitioning from traditional pedagogical practices to those more aligned with contemporary educational demands, including integrating technology effectively into their teaching (Ertmer & Ottenbreit-Leftwich, 2010).

1.1.4 Practices for Teacher Development

Professional development programs that empower teachers are essential for enhancing educational outcomes. High-quality professional development should be ongoing, collaborative, and relevant to teachers' immediate contexts (Darling-Hammond et al., 2017). By examining effective practices for teacher development, this research aims to outline actionable strategies that foster an environment where teachers can thrive as learners. The significance lies in building a sustainable teacher workforce capable of innovating and adapting instructional practices that resonate with students' needs in the 21st Century.

1.1.5 Assessment of 21st Century Learning Outcomes

Assessing student learning outcomes in the 21st Century requires a departure from traditional assessment methods that primarily measure rote memorization and basic skills. Instead, innovative assessment practices that evaluate critical thinking, creativity, and collaboration are essential (Buck Institute for Education, 2019). This research addresses the need for comprehensive assessment strategies that reflect the competencies required in modern society. Empowering teachers to design and implement these assessments enhances their understanding of student learning and fosters a deeper engagement among students as active participants in their learning journeys.

1.1.6 Conclusion

The significance of researching the empowerment of teachers to enhance student learning as 21st-century learners cannot be overstated. By focusing on educational innovations and addressing the multifaceted challenges teachers face, this research highlights educators' critical role in student success. The integration of the 21st Century Skills Framework, the evolving role of teachers, ongoing professional development practices, and innovative assessment strategies play a vital part in shaping a new generation of learners prepared to navigate the complexities of the global landscape. As educational paradigms shift, the empowerment of teachers emerges as a fundamental component in achieving meaningful educational transformations.

1.2 Research Purpose

This research is focused on employing the Research and Development (R&D) methodology to create an innovative educational program that enhances teaching practices in a modernized context. Specifically, the program will be an effective online self-training initiative designed to equip teachers with the knowledge and skills to better understand and support 21st-century learners across various dimensions, including cognitive, emotional, and social aspects. The online self-training program will be divided into two distinct yet interconnected projects:

Project One: Development of Teacher Knowledge on 21st-Century Learners. This project will provide comprehensive training for educators on the essential principles and practices of cultivating 21st-century skills in their students. It will cover various topics such as critical thinking, collaboration, digital literacy, and adaptability. Through interactive modules, real-world case studies, and assessment tools. Teachers will gain insights into modern learners' specific needs and characteristics through interactive modules, real-world case studies, and assessment tools, enabling them to create more engaging and effective learning environments.

Project Two: Practical Application of Learning Outcomes. The second project will focus on implementing the knowledge acquired in the first project. Teachers will be guided in applying the insights gained into practical strategies that can be utilized in their classrooms. This phase will include hands-on activities, lesson planning sessions, and collaborative exercises where teachers can refine their approaches to meet the diverse needs of their students. Additionally, there will be opportunities for feedback and reflection to enhance teaching practices further.

Ultimately, this dual-project online self-training program aims to empower educators by providing them with the resources and support needed to enhance their teaching methodologies. This will directly benefit their students and promote a more effective learning experience tailored to the demands of the 21st Century.

1.3 Research Hypothesis

Numerous researchers have successfully investigated concepts similar to those outlined by Sanrattana (2023), consistently demonstrating the effectiveness of developed educational innovations in alignment with well-defined research hypotheses. Landmark studies such as "Empowering Teachers' Learning to Enhance Students' Change Leadership Skills" by Praneetpolkrung and Supakicco (2023), "Developing Teachers to Develop Students' 21st-Century Skills" by Mopara and Sanrattana (2023), and "Enhancing Teachers' Learning to Develop Students to Become Successful Students" by Thammabut and Thacha (2023) showcase this trend.

Building upon these solid foundations, we are confident that this research will produce impactful educational innovations that align precisely with our research hypotheses. We propose the following expected outcomes:

1) Under the "Teachers Develop Themselves to Learn about 21st-Century Learners Project," we firmly anticipate that, following the experimental research in the R5D5 step, teachers in the experimental group will achieve post-test scores meeting or exceeding the standard criteria of 90/90, significantly surpassing their pre-test scores.

2) Regarding the "Teachers Bring Learning Outcomes to Practice with Students" project, we confidently predict that students in the experimental group will show a marked increase in their evaluations of 21st-century learner skills following the experiment, significantly outpacing their assessment before the intervention.

These hypotheses are designed to validate the crucial role of empowering teachers to enhance the Learning and development of their students, equipping them to meet the challenges of the 21st Century with confidence and skill.

1.4 Literature Review

The research we conducted capitalized on the advancements in digital technology and the expansive access to modern knowledge available on the Internet in the 21st Century, drawing information from various countries. We relied on a wealth of reliable articles aligned with our research objectives, which aimed to present content from a modern perspective for creating learning modules for teachers. Our goal was to help educators develop their understanding of 21st-century learners across multiple dimensions before implementing the learning outcomes in their classrooms effectively.

Rather than gathering scientific knowledge through quantitative research, we focused on a literature review to identify variables and indicators relevant to our study. We reviewed expert opinions from around the globe, synthesized in articles on various topics concerning 21st-century learners, which include:

1) Definition of 21st-century skills–perspectives were gathered from sources such as The Great Schools Partnership (2016), One World International School (2020), Power (2021), Buckle (n.d.), The Classical Academies (n.d.), and University of Auckland (n.d.).

2) The importance of learners in the 21st Century–insights from Careerindia (2014), Haroon (2017), Surya (2017), Abroad learners (2022), and University Eaton (n.d.) shaped our understanding.

3) Characteristics of teachers in the 21st Century–contributions from Churches (2014), Cox (2019), Hooda (2019), Sailors' Pride School (2019), and University Ecole Global International Girls School (2020) were analyzed.

4) Guidelines for developing the role of teachers in the 21st Century–perspectives from Billah (2013), Flamand (n.d.), Nola (n.d.), The Progressive Teacher (n.d.), and Tunjera (n.d.) provided foundational insights.

5) Steps to develop skills for teachers in the 21st Century–we referenced Haranaka (2018), Pius (2019), Primera Courses (2019), Parimi (2021), Ecole Globale International Girls School (n.d.), and Teach Opians (n.d.).

6) Obstacles in the development of 21st-century teachers–insights from High School Access (2019), Praveena (2020), Gurudrasil (2021), Barrington (2022), and Gama Learn (n.d.) were crucial for understanding challenges.

7) Guidelines for developing students to become 21st-century learners–We considered perspectives from Riedel (2009), Mielke (2015), Rink (2016), Mansori (2019), Oxford University Press ELT (2019), Kreiness (2022), Be Techer (n.d.), and Nording (n.d.).

8) Assessment of 21st-century learners: The viewpoints of White, Tufts, Grube, and Taylor (2012), Kharbach (2014), Abdallah (n.d.), Bukidnon State University (n.d.), Ravitz (n.d.), Rusdin (n.d.), University of Maine (n.d.), and Wiggers (n.d.) were explored.

This comprehensive literature review offers valuable insights to inform our approach to 21st-century education and learner development. Presenting content as learning modules and having teachers complete online self-training beforehand will help them thoroughly understand all topics. This knowledge will enable them to apply what they've learned to their students effectively.

Among these topics, we identified "development approaches" as key suggestions covering principles, concepts, techniques, methods, and activities. These approaches will help teachers understand how to support 21st-century learners. While some methods are already known, many others may be new due to the changes in the 21st Century.

We compiled a list of 29 development approaches based on various studies, including perspectives from White, Tufts, Grube, Taylor (2012), Kharbach (2014), and others. These approaches include:

1) Individualistic students
2) Teachers playing multiple roles
3) Teachers managing too much paperwork
4) Increased demands from school administrators
5) Maintaining good communication with parents
6) Changes in classroom management
7) Technology use
8) Common core state standards
9) Literacy rates
10) Bullying
11) Parent involvement
12) Poverty
13) Funding
14) Support
15) Classroom size
16) Encouraging students to be self-directed
17) Encouraging students to do their work outside the classroom
18) One-size-fits-all teaching
19) Pressure to perform well
20) Dealing with demanding parents
21) Limitations in student discipline
22) Standardized testing
23) Lack of recognition
24) Identifying practical ideas
25) Low motivation and interest among students
26) Lack of personal time for teachers
27) Unequal parental commitment to children's Learning
28) Teacher fatigue and burnout
29) Handling many responsibilities.

2. Research Methodology

2.1 Procedures

This research utilized the Research and Development (R&D) Methodology to create educational innovations. According to Sanrattana (2023), it is vital to "bring up-to-date knowledge in the 21st Century from various perspectives of reliable individuals or agencies." The aim is to develop Learning Modules focusing on enhancing teachers' capabilities first, allowing them to apply the resulting knowledge to their students. This approach goes beyond the traditional notion of "Knowledge is Power," which was prevalent in the 20th Century, emphasizing a more collaborative and comprehensive strategy for educational growth. The research steps were in the R1D1 …. RiDi format as follows:

R1D1 Process: This phase involved reviewing literature on 21st-century learners, focusing on 1) Definitions of 21st-century skills, 2) Importance of these learners, 3) Characteristics of teachers, 4) Guidelines for teacher

development, 5) Steps for skill development, 6) Obstacles in teacher development, 7) Guidelines for developing 21st-century learners, and 8) Evaluation methods. The findings will be organized into eight learning modules.

R2D2 Process: An online self-training program was created with two projects: 1) The Teacher Self-Development Project, which includes the eight modules from R1D1, and 2) The Teacher Transforms Learning Outcomes into Practice Project, featuring topics like clarifications, summaries of 21st-century skills and learner importance, teacher characteristics, development guidelines, and various assessment forms. The program aims to empower teachers to enhance student learning as 21st-century learners. Full details of the Thai program can be accessed at https://shorturl.at/0LSJx.

R3D3 Process: The content's accuracy, especially translations, was verified through focus group discussions with teachers in two phases: a preliminary phase with five teachers and a main testing phase with ten teachers.

R4D4 Process: Two research instruments were created: a teacher learning outcome test and an achievement evaluation form (details in the research tools section).

R5D5 Process: Experimental research using a One Group Pretest-Posttest Design was conducted in a randomly selected school with eight teachers and 121 students during the second semester of 2024. The research had two phases: 1) a month of self-development for teachers on 21st-century skills and 2) two months of applying those skills with students.

2.2 Research Tools

The Teacher Learning Outcome Test was designed as a 4-choice multiple-choice assessment aligned with the Cognitive Domain, emphasizing skills such as remembering, understanding, applying, analyzing, evaluating, and creating by A Revision of Bloom's Taxonomy (Krathwohl, 2002). The quality of this test underwent two phases of evaluation.

In the first phase, Content Validity was assessed using the Indexes of Item-Objective Congruence (IOC) method outlined by Rovinelli and Hambleton (1977). This assessment involved five educational experts, and the analysis revealed that all items were suitable for measuring the intended outcomes, as the IOC values exceeded the threshold of 0.50 (Chaichanawirote & Vantum, 2017).

The second phase involved administering the test to 30 teachers from a school outside the experimental area to evaluate its overall quality. The data analysis yielded several key findings: 1) All questions met the Index of Difficulty criteria of 0.20 - 0.80 and displayed a Power of Discrimination ranging from 0.20 to 1.00. 2) The KR-20 reliability coefficient was calculated at 0.91, surpassing the acceptable benchmark of 0.70. 3) The test's overall difficulty level was measured at 59.08.

The 21st-Century Learners Assessment of Students utilized a 5-level Rating Scale that includes Strongly Agree, Agree, Neutral, Disagree, and Strongly Disagree. This assessment was informed by extensive literature on the characteristics of 21st-century learners, drawing insights from Careerindia (2014), Haroon (2017), Surya (2017), Abroad Learners (2022), and Eaton (n.d.), as well as from literature regarding assessment guidelines for these learners, as described by White, Tufts, Grube, and Taylor (2012), Kharbach (2014), Abdallah (n.d.), Bukidnon State University (n.d.), Ravitz (n.d.), Rusdin (n.d.), the University of Maine (n.d.), and Wiggers (n.d.).

Quality assessment of this tool occurred in two stages. In the first stage, five educational experts evaluated the content validity of the assessment. The analysis revealed that all questions achieved an Index of Item-Objective Congruence (IOC) value exceeding 0.50, confirming their suitability for the intended purpose.

The second stage focused on examining the reliability or internal consistency of the assessment by administering it to 30 students from a school outside the experimental area. The results indicated that the overall Alpha Coefficient of Reliability was 0.83. A breakdown of analysis for each aspect demonstrated that the reliability coefficients for Collaboration, Communication, Creativity and Innovation, Problem-Solving, Critical Thinking, Self-Direction, and Using Technology as a Tool for Learning were 0.82, 0.84, 0.86, 0.88, 0.83, 0.79, and 0.80, respectively. All these values exceeded the acceptable criterion of 0.70 (George & Mallery, 2003).

2.3 Data Analysis

The standard criteria of 90/90 are analyzed following the guidelines set by Yamkasikorn (2008). To calculate the first 90, the formula used is $90 = \{(\Sigma X / N) \times 100\} / R$. Here, the first 90 represents the percentage of the average score from the post-test. In this formula, ΣX is the total score reflecting the correct answers by each learner on the post-test, N is the total number of learners in the sample used for this efficiency calculation, and R is the full score of the post-test.

For the last 90, the formula is $(Y \times 100)/N$. In this case, the previous 90 signifies the percentage of learners who

passed all test objectives, where Y is the number of learners who achieved that success. N again refers to the total number of learners in the sample relevant to this efficiency assessment.

To evaluate the effectiveness of the intervention, mean scores from pre-tests and post-tests were compared using the dependent t-test method. This analysis aimed to determine the impact of instructional strategies on teachers' performance relative to the established standards.

3. Research Results

The results of the research to test the effectiveness of the online self-training program "Empowering the Learning of Teachers in Order to Strengthen Their Students so that They Can Become 21st-Century Learners" were found to support the research hypothesis as follows:

3.1 Results of Testing the Research Hypothesis No. 1

Following the experimental research within the project focused on the development of teachers concerning 21st-century learners using the R5D5 process, the findings revealed: 1. Eight teachers in the experimental group achieved an average score from the post-experiment test of 33.63 points, corresponding to 93.40 percent of the total score of 36 points, aligning with the first 90 standard criteria. 2. One hundred percent of teachers in the experimental group successfully passed the test per all objectives, meeting the criteria outlined in the last 90 standard guidelines.

Additionally, the data indicated that the average teacher score on the pre-experiment test was 28.25, with a standard deviation of 2.25. The average score on the post-experiment test was 33.63, with a standard deviation of 1.19. Table 1 provides a comparison of the pre-experiment and post-experiment scores conducted using dependent t-tests. The post-experiment test score was significantly higher than the pre-experiment score at 0.05.

Table 1. Teachers' mean scores from pre-and post-tests were compared using a dependent t-test

Testing	Sample size	Mean	Standard Deviation	t
Before	8	28.25	2.25	6.72*
After	8	33.63	1.19	

*Significant at ($p<0.05$).

The analysis presented in Table 1 indicates a notable improvement in teacher scores from the pretest to the posttest following the intervention. Specifically, the mean pretest score was 28.25, with a standard deviation of 2.25, while the mean posttest score increased to 33.63, with a standard deviation of 1.19.

The statistical analysis, as indicated by the t-value of 6.72, reveals a strong significance with a p-value less than 0.05. This suggests that the observed difference in scores is unlikely to have occurred by chance, providing robust evidence that the intervention substantially enhanced the teachers' performance or knowledge.

Overall, these findings highlight the effectiveness of the intervention in improving teachers' capabilities, demonstrating a tangible benefit from the program implemented.

3.2 Results of Testing Research Hypothesis No. 2

Following the experimental research centered on the project where teachers applied learned strategies with students through the R5D5 process, the 121 students in the experimental group utilized the "21st-Century Learners Assessment of Students" to evaluate their Learning. The results from this assessment, which were analyzed both before and after the experiment, revealed significant improvements overall and advancements in specific aspects of Learning.

The findings illustrate a marked enhancement in the students' engagement with 21st-century skills, affirming the effectiveness of the self-development project in fostering significant learning outcomes. Detailed data on the mean scores, alongside the classification of results by each evaluated aspect, underscore the positive impact of the program on both teachers and students in cultivating competencies essential for the 21st Century, are shown in Table 2 as follows.

Table 2. Mean and standard deviation of the 21st-century learner's assessment results of students before and after the experiment, overall and in each aspect

Students' characteristics that meet 21st-century learners	Assessment results			
	Before		After	
	$\bar{X}$	S.D.	$\bar{X}$	S.D.
Collaboration	3.07	1.22	4.11	0.86
1) I value other people's opinions.	2.96	1.15	4.15	0.88
2) I work in pairs or small groups to complete tasks simultaneously.	2.89	1.24	4.16	0.89
3) I present my group work to the class, teacher, or others.	2.95	1.32	4.24	0.81
4) I am adaptable and flexible.	3.16	1.20	4.14	0.87
5) I respect the experiences or perspectives of others when expressing opinions or ideas without bias.	2.98	1.29	4.07	0.96
6) I can work well in a team.	3.49	1.1	3.92	0.73
Communication	3.52	1.19	4.08	0.89
7) I can communicate well.	3.60	1.17	4.03	0.88
8) My verbal communication is clear.	3.57	1.24	4.08	0.94
9) I communicate my ideas using media other than paper, such as posters and videos.	3.68	1.18	4.24	0.83
10) I can convey ideas graphically.	3.45	1.30	4.25	0.84
11) I communicate clearly, using a variety of communication channels to convey my ideas most effectively.	3.52	1.12	3.94	1.04
12) I can present information and ideas clearly and concisely, using content and format appropriate to my audience.	3.33	1.11	3.93	0.84
Creativity and Innovation	3.85	1.30	4.19	0.94
13) I can devise solutions to complex, open-ended questions or problems.	3.92	1.29	4.26	0.82
14) I demonstrate initiative and creativity in my work.	3.83	1.40	4.24	0.99
15) I use ICT to create media.	3.61	1.38	4.11	0.84
16) I think creatively and can develop new ways to solve problems.	3.93	1.25	4.15	1.03
17) I am digitally and technologically fluent.	3.79	1.20	4.17	0.93
18) I brainstorm and look for opportunities to improve my thinking and how I respond to situations.	4.01	1.25	4.22	1.04
Problem-solving	3.29	1.49	4.14	0.91
19) I can clearly describe the nature of the problem.	2.71	1.63	4.12	0.90
20) I can evaluate alternatives, propose possible solutions, and determine the consequences of alternatives.	3.74	1.31	4.23	0.88
21) I choose real-life situations and problems.	3.19	1.62	4.26	0.83
22) I negotiate to solve problems peacefully or in a compromise everyone can accept.	3.28	1.56	4.20	0.89
23) I break down problems into small or simple parts and develop guidelines for solving them.	3.44	1.43	4.04	0.97
24) I have developed the ability to adapt to new situations and environments.	3.37	1.37	3.97	0.96
Critical Thinking	3.61	1.45	4.21	0.89
25) I examined all possible solutions, both their pros and cons.	3.79	1.43	4.26	0.99
26) I try to solve complex problems or answer questions that do not have a single correct solution or answer.	3.94	1.39	4.45	0.76
27) I summarize or create my interpretation from what I have read or been taught.	3.68	1.31	4.22	0.82
28) I can analyze data, summarize findings, and write reports.	3.14	1.60	4.17	0.90
29) I plan procedures to complete a complex task.	3.64	1.59	4.12	0.98
30) I think creatively and can develop methods to compare information from different sources before completing a task or assignment.	3.46	1.38	4.05	0.91
Self-Direction	3.46	1.47	4.12	0.87
31) I take the initiative when faced with complex problems or questions.	3.51	1.43	4.08	0.91
32) I select a learning topic or question I want to follow up on.	3.48	1.40	4.02	0.90
33) I track my progress in completing complex tasks and revise them accordingly.	3.42	1.49	4.15	0.86
34) I reflect and evaluate my creative work honestly.	3.77	1.51	4.39	0.76
35) I use feedback from friends, teachers, or experts to edit my work.	3.26	1.46	3.93	0.97
36) I use specific criteria to evaluate the quality of work before it is completed.	3.32	1.53	4.14	0.85
Using Technology as a Tool for Learning	3.33	1.36	4.06	0.9

37) I select the right technology tools or resources to complete the job.	3.62	1.24	3.99	0.98
38) I use technology to analyze data (e.g., databases, spreadsheets, graphics programs).	3.71	1.14	4.19	0.88
39) I use technology to analyze data (e.g., databases, spreadsheets, graphics programs).	3.06	1.46	4.04	0.78
40) I use technology to support teamwork or collaboration (e.g., shared workspaces, email exchanges, giving and receiving feedback).	3.44	1.43	4.11	0.87
41. I use technology or the internet for self-teaching (e.g., Kahn Academy or other videos, exercises, and self-teaching websites).	3.10	1.45	3.91	1.05
42) I use technology to keep track of my assignments.	3.06	1.44	4.15	0.84
Total	3.45	1.35	4.13	0.90

Table 2 presents a comprehensive summary of the assessment results before and after the experiment. The overall mean score from the pre-experiment assessment was measured at 3.45, accompanied by a standard deviation of 1.35. This indicates the average performance of participants before the intervention, along with the variability of their scores. In contrast, the mean score from the post-experiment assessment rose to 4.13, with a standard deviation of 0.90, reflecting an improvement and greater consistency in the participants' performances following the intervention.

When reflecting on the remarkable growth observed from before to after the experiment, each aspect has shown positive transformation: Collaboration surged from 3.07 to 4.11 (+1.04), Communication blossomed from 3.52 to 4.08 (+0.56), Creativity & Innovation elevated from 3.85 to 4.19 (+0.34), Problem-Solving thrived from 3.29 to 4.14 (+0.85), Critical Thinking advanced from 3.61 to 4.21 (+0.60), Self-Direction flourished from 3.46 to 4.12 (+0.66), and Using Technology as a Tool for Learning progressed from 3.33 to 4.06 (+0.73). The Overall Average reflects an inspiring increase from 3.45 to 4.13 (+0.68).

A dependent t-test was conducted to determine the statistical significance of this improvement. The analysis revealed that the post-experiment assessment scores were significantly higher than those from the pre-experiment assessment, with a p-value less than the threshold of 0.05, as shown in the data analysis results in Table 3.

Table 3. This suggests that the intervention had a statistically meaningful impact on the participants' performance

Assessment	Sample size	Mean	Standard Deviation	t
Before	121	3.45	1.35	14.61*
After	121	4.13	0.90	

*Significant at ($p<0.05$).

The analysis in Table 3 indicates a notable improvement in teacher scores from the pretest to the posttest following the intervention. Specifically, the mean pretest score was 3.45, with a standard deviation of 1.35, while the mean posttest score increased to 4.13, with a standard deviation of 0.90. The statistical analysis, as indicated by the t-value of 14.61, reveals a strong significance with a p-value less than 0.05.

The analysis in Table 3 shows a significant improvement in teacher scores from the pretest to the posttest after the intervention. Specifically, the mean pretest score was 3.45, with a standard deviation of 1.35, while the mean posttest score rose to 4.13, with a standard deviation of 0.90. The statistical analysis, indicated by a t-value of 14.61, demonstrates strong significance, with a p-value less than 0.05.

This analysis confirms that the "Teachers' Project to Implement Learning Outcomes with Students" possesses qualities suitable for dissemination and practical application in real-world educational settings. These findings align with those of the previously discussed initial project, reinforcing the effectiveness of the implemented strategies. The data suggest that the project met its objectives and shows promise for broader adoption in similar contexts.

The "Teachers' Project to Implement Learning Outcomes with Students" demonstrates a quality suitable for dissemination and practical application in real-world educational settings. This conclusion aligns with the results found in the initial project previously discussed, indicating consistency in the effectiveness of the implemented strategies. The data suggest that the project met its objectives and holds promise for broader adoption in similar contexts.

In light of these comprehensive findings, it is recommended that the "Teachers' Project to Implement Learning

Outcomes with Students" be strategically expanded across a broader range of educational settings, particularly those with similar demographic and socioeconomic characteristics. Future iterations of the program should strongly emphasize establishing sustained support networks for educators and parents, ensuring they are equipped with the necessary resources and training to foster an optimal learning environment.

Moreover, it is crucial to delve deeper into further research to investigate the long-term retention of the skills and knowledge imparted through the project. This research should focus on how well the learning outcomes are maintained over time and explore classroom-level adaptations that can cater to diverse school environments, accommodating varying learning needs and teaching methodologies.

Engaging a variety of stakeholders—including teachers, school administrators, parents, and community organizations—in this initiative will enhance the overall effectiveness of the project. Their input will be invaluable in crafting a tailored approach to dissemination, thereby increasing the likelihood of successful implementation and broader adoption of the strategies employed in this project. We can significantly improve educational outcomes across multiple contexts by fostering collaborative partnerships and emphasizing sustainability.

4. Discussion

This research aimed to employ the Research and Development (R&D) methodology to create an innovative educational tool: an online self-training program designed to effectively meet specified criteria for teachers. The program is intended to help educators study and enhance their understanding of 21st-century Learners across multiple dimensions before they apply the insights gained to their students.

The online self-training program comprises two key projects: 1) a project focused on equipping teachers with knowledge on developing their students into 21st Century Learners, and 2) a project that enables teachers to implement these learning outcomes with their students.

The results from testing research hypotheses 1 and 2 indicate that the "Online Self-Training Program: Empowering the Learning of Teachers to Strengthen their Students to Become 21st Century Learners," which encompasses these two projects, is effective and suitable for dissemination to the target population. This conclusion aligns with the principles of R&D methodology, which emphasizes the testing and development of innovations in representative trial areas. Once the experimental results demonstrate that the innovation meets the established criteria for efficacy, it is deemed ready for broader implementation within the target population.

The success of this research can be attributed to our design, which focused on the principles of modern professional development for teachers. We emphasized the importance of equipping educators with knowledge and encouraging them to apply it to impact student development positively. This approach helped teachers concentrate on their primary objective—enhancing learner outcomes—rather than merely accumulating information as was common in the past. As noted by Kaplan (n.d.), effective teacher development should be an ongoing experience, embedded in the job, and provide support during the implementation of new instructional methods. It should also offer specific content rather than generic content, engage teachers through varied approaches, incorporate modeling, and foster collaboration among educators. This aligns with the five principles of teacher professional development outlined by Edmentum (2018), which include 1) allowing time for teachers to learn and navigate the challenges of implementing new strategies, 2) providing tailored support during the implementation stage, 3) ensuring that initial exposure to concepts is engaging and active, 4) utilizing modeling as a powerful tool for understanding new practices, and 5) presenting content that is relevant to specific disciplines or grade levels.

Furthermore, as our research falls within educational administration, our team considered two essential components: "Means" and "End." The "End" refers to establishing a high-quality educational system centered on the learners. The "Means" involves the processes required to achieve these objectives, mobilizing both human and material resources to enhance the quality of teaching and Learning, which benefits the learners.

This perspective aligns with the characteristics of 21st Century Learners, which include collaboration, communication, creativity and innovation, problem-solving, critical thinking, self-direction, and adeptness in using technology for Learning. Such qualities reflect the ultimate goal of education. Additionally, we examined 37 effective teaching methods as suggested by White, Tufts, Grube, and Taylor (2012), Kharbach (2014), Abdullah (n.d.), and others. These guidelines can serve as alternatives to traditional teaching methods, helping students develop the characteristics expected of 21st Century Learners.

Our research methodology resonates with Amadi (2008), who views educational administration as utilizing personnel and resources to foster effective teaching and Learning in schools. Dhammei (2022) also emphasizes

that educational administration guides students to receive appropriate education from skilled teachers, influencing their growth toward established goals by positioning educators as change leaders. Ultimately, educational administration aims to create, maintain, and energize institutions to achieve predetermined objectives. Zakir (2012) adds that educational administration involves designing institutions that promote teaching and Learning. Bamte (n.d.) highlights the administration's role in developing policies, stimulating suitable programs, managing personnel and materials, and ensuring the effective use of resources to cultivate human potential.

5. Conclusion

The research has made significant strides in achieving its objectives by effectively disseminating impactful educational innovations to the 6,882 schools governed by the Office of the Basic Education Commission. Despite these successes, the journey towards cultivating 21st-century learners is fraught with complexities and challenges that educators must navigate.

Teachers frequently grapple with time constraints as they balance many responsibilities that extend beyond teaching alone. These responsibilities encompass lesson planning, grading, classroom management, and administrative tasks, which can lead to overwhelming workloads. Feedback from educators underscores several pressing issues: excessive paperwork that consumes valuable time, escalating demands from school administrators who often prioritize compliance over creativity, and an urgent need for improved communication channels with parents, who play a pivotal role in their children's educational journey.

However, within this landscape of challenges lies a significant opportunity to foster self-directed Learning among students, bolster parental involvement, and rejuvenate student motivation. By creating a supportive and collaborative environment, educators can not only mitigate feelings of burnout but also inspire a renewed commitment to their essential role in student empowerment. This ongoing professional development and support are crucial for equipping learners with the skills and mindset necessary to thrive in an increasingly dynamic and diverse educational landscape. Emphasizing collaboration, innovation, and adaptability will ultimately contribute to the holistic development of students as they prepare to meet the challenges of the future.

References

Abdallah, L. N. (n.d.). *21st-Century skills checklist*.

Abroad learners. (2022). *21st-Century learners' characteristics*.

Amadi, E.C. (2008). *Introduction to educational administration; A module*. Port Harcourt: Harey Publications.

Bamte. (n.d.). *Educational administration–This means authoritarian and democratic educational management*.

Barrington, K. (2022). *Top 10 challenges facing public school teachers in 2017*. Retrieved from https://shorturl.asia/MAP0t

Be Teacher. (n.d.). *Empowering students for the future workplace*.

Billah, M. (2013). *Role of teachers in the 21st Century*. Retrieved from https://shorturl.asia/aM104

Buck Institute for Education. (2019). *Designing project-based learning assessments*. Retrieved from https://www.pblworks.org/resources

Buckle, J. (n.d.). *A comprehensive child's 21st-century skills*. Retrieved from https://shorturl.asia/yto3l

Bukidnon State University. (n.d.). *Questionnaire for teachers' practices on the 21st-Century skills*. Retrieved from https://shorturl.asia/zxb0Q

Careerindia. (2014). *Seven Characteristics of 21st Century Learning*. Retrieved from https://shorturl.asia/qXD93

Chaichanawirote, U., & Vantum, C. (2017). Evaluation of content validity for research instrument. *Journal of Nursing and Health Sciences, 11*(2),105-111.

Churches, A. (2014). *Eight characteristics of the 21st-century teacher*.

Cox, J. (2019). *Characteristics of a 21st-century teacher*. Retrieved from https://shorturl.asia/ytQrF

Darling-Hammond, L., Hyler, M. E., & Gardner, M. (2017). *Effective teacher professional development*. Palo Alto, CA: Learning Policy Institute. https://doi.org/10.54300/122.311

Desimone, L. M. (2009). Improving impact studies of teachers' professional development: A 5-year study of the impact of a teacher professional development program. *Educational Policy, 23*(3), 445-488. https://doi.org/10.3102/0013189X08331140

Dhammei, T. (2022). *Educational administration: Concepts of educational administration and principles of*

educational administration.

Eaton, S. E. (n.d.). *21 Characteristics of 21st-century learners*. Retrieved from https://shorturl.asia/sbG5u

Ecole Global International Girls School. (2020). *Characteristics of a 21st-century teacher*. Retrieved from https://shorturl.asia/WwSR7

Ecole Global International Girls School. (n.d.). *21st-Century skills for teachers*. Retrieved from https://shorturl.asia/NUaTX

Edmentum. (2018). *Five principles of professional development for teachers.* Retrieved from https://bit.ly/3ZNjVoz

Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2010). Teacher technology change: How knowledge, confidence, beliefs, and culture interact. *Journal of Research on Technology in Education, 42*(3), 255-284. https://doi.org/10.1080/15391523.2010.10782551

Flamand, L. (n.d.). *Role of teachers in the 21st Century*. Retrieved from https://shorturl.asia/Lu0ZG

Gama Learn. (n.d.). *Seven significant challenges facing teachers today*. Retrieved from https://shorturl.asia/QgfO0

George, D., & Mallery, P. (2003). *SPSS for Windows step by step: A simple guide and reference. 11.0 updat*e (4th ed.). Allyn & Bacon.

Gurudrasil. (2021). *Top 10 challenges faced by teachers*. Retrieved from https://shorturl.asia/cwQMF

Haranaka, L. (2018). *21st-Century skills for teachers*. Retrieved from https://shorturl.asia/cgQ6a

Haroon, S. (2017). *Six major characteristics of 21st-century learners*. Retrieved from https://shorturl.asia/dBAmP

High School Access. (2019). *What challenges do teachers face today?* Retrieved from https://shorturl.asia/cNyKt

Hooda, S. (2019). *Five defining characteristics of a 21st-century teacher*. Retrieved from https://shorturl.asia/b20Ti

Ignite Thailand. (2020). *The role of learners in the 21st Century*. Retrieved from https://shorturl.asia/JUuN8

Kaplane (n.d.). *The principles of effective professional development*. Retrieved from https://bit.ly/3Tc1IOT

Kharbach, M. (2014). *A comprehensive checklist of the 21st-century Learning and work skills*. Retrieved from https://shorturl.asia/Esx2i

Krathwohl, D. R. (2002). A Revision of Bloom's taxonomy: An overview. *Theory Into Practice, 41*(4), 212-218. https://doi.org/10.1207/s15430421tip4104_2

Kreiness, D. (2022). *Five ways to empower students as content creators*. Retrieved from https://shorturl.asia/PpYEM

Mansori, M. (2019). *Empowering student action through 21st-century skills and the SDGs*. Retrieved from https://shorturl.asia/b1aTu

Mielke, C. (2015, November 18). *Empowering students to change the world*. Retrieved from https://shorturl.asia/H7dFS

Mopara, R., & Sanrattana, W. (2023). Developing teachers to develop students' 21st-century skills. *World Journal of Education, 13*(3), 94-104. https://doi.org/10.5430/wje.v13n3p94

Nola, A. (n.d.). *The seven roles of a teacher in the 21st Century*. Retrieved from https://shorturl.asia/ROFsX

Nording, C. (n.d.). *Empowering students to create, collaborate, and communicate*. Retrieved from https://shorturl.asia/d2aSG

Office of National Higher, Education Science Research and Innovation Policy Council. (2021). *Adjust the guidelines for Thai education*. Retrieved from https://shorturl.asia/LvfuO

Office of the Basic Education Commission, Ministry of Education. (2015). *In the guidelines for organizing learning skills in the 21st Century, emphasis is placed on professional competence*. Retrieved from https://shorturl.asia/mqlyc

One World International School. (2020). *Developing 21st-century skills in students*. Retrieved from https://Shorturl.Asia/8NBC7

Oxford University Press ELT. (2019, November 4). *Glstudents'ls–Create empowered 21st-century learners*.

P21. (2019). *Framework for 21st Century Learning*. Retrieved from http://www.p21.org/our-work/p21-framework

Parimi, P. (2021, April 2). What skills should 21st-century teachers be equipped with?

Pius, G. (2019, May 16). *Ten top 21st-century teacher skill sets*. Retrieved from https://shorturl.asia/ragc1

Power, M. (2021). *What are 21st-century skills?* Retrieved from https://shorturl.asia/Zdgk7

Praneetpolkrung, K., & Supakicco, P.S. (2023). Empowering teachers' Learning to enhance students' change leadership skills. *World Journal of Education, 13*(3), 1-12. https://doi.org/10.5430/wje.v13n3p1

Praveena. (2020). *Ten challenges faced by teachers today and tips to overcome them*. Retrieved from https://shorturl.asia/rfxQW

Primera Courses. (2019). *Six important skills a modern teacher has to have*. Retrieved from https://shorturl.asia/k8Lpo

Ravitz, J. (2014). *A survey for measuring 21st-century teaching and Learning: West Virginia 21st-century teaching and learning survey*. Retrieved from https://bit.ly/2ZZi7K8

Rovinelli, R. J., & Hambleton, R. K. (1977). On the use of content specialists in the assessment of criterion-referenced test item validity. *Dutch Journal of Educational Research, 2*, 49-60.

Rusdin, N. M. (2018). Teachers' Readiness in Implementing 21st-century Learning. *International Journal of Academic Research in Business and Social Sciences, 8*(4), 1271-1284. https://doi.org/10.6007/IJARBSS/v8-i4/4270

Sailors' Pride School. (2019). *Fifteen characteristics of a 21st-century teacher*. Retrieved from https://shorturl.asia/d8exm

Sanrattana, W. (2023). *Research in educational administration: Concepts, practices and case studies* (5th ed.). Bangkok: Thiphawisut.

Surya, C. (2017). *The characteristics of 21st-century learner*. Retrieved from https://shorturl.asia/m9nYc

Teach Opians. (n.d.). *A list of the most important 21st-century skills teachers should have*. Retrieved from https://shorturl.asia/fXY0n

Thammabut, B., & Thacha, W. (2023). Enhancing teachers' learning to develop students to become successful students. *World Journal of Education, 13*(3), 13-23. https://doi.org/10.5430/wje.v13n3p13

The Classical Academies. (n.d.). *21st-Century skills*. Retrieved from https://shorturl.asia/AFL8M

The Great Schools Partnership. (2016). *21st-Century skills*. Retrieved from https://shorturl.asia/87FeL

The Progressive Teacher. (n.d.). *The changing role of a 21st-century educator*. Retrieved from https://shorturl.asia/YcfKi

The University of Auckland. (n.d.). *What are 21st-century skills?* Retrieved from https://shorturl.asia/1DRSy

The University of Maine. (n.d.). *21st-Century skills checklist*. Retrieved from https://shorturl.asia/FQv6Y

Tunjera, N. (n.d.). The roles of a 21st-century teacher. Retrieved from https://shorturl.asia/A85zP

Voogt, J., & Roblin, N. P. (2012). 21st-century skills: Discuss definitions and levels of proficiency. *Computers & Education, 57*(2), 401-409.

White, B. J., Tufts, S., Grube, A. J., & Taylor, M. D. (2012). The effect of attending professional meetings on perceptions of workplace skills teacher students. *Issues in Information Systems, 13*(2), 96-103.

Wiggers, M. (n.d.). A twenty-first-century skills checklist for students. Retrieved from https://shorturl.asia/sJke8

Yamkasikorn, M. (2008). How to use efficiency criterion in media research and development: The difference between 90/90 standard and E1/E2. *Education Journal Burapha University, 19*(1), 1-16.

Zakir, I. (2012). *Educational administration*. Retrieved from https://www.slideshare.net/Imran764/educational-administration

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Authors contributions

Supansa Boonphum, a doctoral student in Educational Administration, initiated the research by identifying an important topic and establishing its relevance. She defined the objectives, conducted a comprehensive literature review, and formulated a methodological approach tailored to the research goals. Throughout the project, Wirot Sanrattana and Phrasrivajiravati, her advisors, provided ongoing guidance, expert advice, and thorough feedback, collectively ensuring the integrity and success of the research.

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The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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