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An Online Program to Enhance Teacher Learning to Develop Students' Self-Directed Learning Skills

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Abstract

The objective of this study was to create an “An Online Program to Enhance Teacher Learning to Develop Students' Self-Directed Learning Skills ”based upon the following concepts: “*Develop the teacher so that they will develop their students,*” “Successful teachers, successful students,” and “Knowledge is not power; knowledge plus action equals power.” This study employed Research and Development (R&D) methodology, and the created online program consisted of the following: 1) a project for Teachers’ learning development with six online sets of instructions, and 2) a project for the Teachers to assist in developing students with one set of online action instructions. The created online program was examined by 25 teachers and 146 students in a randomly selected school, which represented the Pariyattidhamma Schools in the General Education section, which is under the National Office of Buddhism. The results validated the fact that the created online program had been effective. The findings illustrated that the post-development test for teachers had met the standard of the 90/90 criteria, and that the mean score had been statistically significantly higher than before the development. In addition, the students’ mean score on the assessment of the self-directed learning skills after the development had been statistically significantly higher than before the development. This indicated that the created online program could be disseminated for educational use in other Pariyattidhamma schools with a similar target population.

Keywords: Self-Directed Learning Skills, Online Program, Research & Development

1. Introduction

The 21st century is being impacted by change, globalization, digitalization, a surge in information, and unforeseen issue scenarios (Zyl & Mentz, 2022). One of the most important 21st-century skills is self-directed learning. Individuals must be able to plan, develop, adapt, and alter their learning in a society that is digital and interactive, and is being globalized. (Brandt, 2020). Furthermore, Karataş, Şentürk, and Teke (2021) mentioned in their study that knowledge of certain disciplines or academic knowledge has fallen out of favor with respect to furthering 21st-century skills. In particular, the 21st-century skills include learning and regeneration skills, learning to learn, managing metacognition, lifelong learning, and self-directed learning skills. In this regard, lifelong learning and self-directed learning skills, which have been defined as “monitoring the individual's own learning process,” are critical for teachers and pre-service teachers, who carry educational policies and curricula and put them into effect. Lifelong learning and self-directed learning are synonymous. At present, people must continue to study throughout

their lives, even if they are not learning in a traditional school setting. To be effective in the lifelong learning process, people must have self-directed learning skills. Because individuals must be able to organize, execute, and manage their own learning process in order to engage in lifelong learning, they must possess the skill of self-directed learning, which was mentioned above.

This concept is in accordance with Weimer (2010), who stated that self-directed learning skills refer to a person's ability to manage learning tasks without being supervised by others. These are skills that are vital for effective lifelong learning and are skills that students are required to develop in college. As students mature and acquire knowledge of the content, they are expected to have self-directed learning skills. In addition, Melkonian (2020) pointed out that self-directed learning describes a process in which an individual takes initiative (with or without the help of others) in diagnosing learning needs, setting learning goals, identifying human and physical resources for learning, and in determining appropriate learning strategies. Moreover, it represents the process of selection and performance to evaluate learning outcomes.

The opposite of self-directed learning is teacher-directed learning, which is often based on what is called "pedagogy," while self-study is based on "andragogy" (Loeng, 2020). Teacher-directed learning is represented by an authoritative person, who is responsible, and who directs and selects the lessons and content. The teacher chooses the groupings and the settings to make sure he / she is the leader of the lesson (Frazier, 2018).

The preceding information showed that the development of self-direction learning skills is critical to today's learning. Therefore, the research team conducted a synthetic study of the perspectives of Alternatives to School (n.d.), Andriotis (2017), Green (n.d.), Gutierrez (2017), Holz (2017), Self-Directed Learning (n.d.), Timpau (2015), and Western Academy of Beijing (2017). The academics believe that self-direction learning skills development can respond to the needs of education in the 21st century and a technological society this is rapidly changing. Self-direction learning skills development prepares students to search for knowledge according to their individual interests and supports the development of psychology and the nature of the learners. Learners can develop their personalities, learn new attitudes, and seek new knowledge, which will lead to lifelong learning, and which will, in turn, bring them many benefits. Learners can learn what they want and are interested in because they are able to determine their own ways of learning. The advantages generated by self-directed learning skills can be clarified as follows: a) objectives and goals can be set; b) there is determination in learning; c) there is the motivation to learn; d) learners can learn by having experiences in a real environment; e) they can implement the learning outcomes in their daily lives; f) they can be creative; g) they can develop good attitudes toward learning; h) learners can build confidence in learning; i) they can develop Self-esteem; j) they can seek new knowledge, k) learners can become self-organized in terms of time and knowledge; l) they can make plans, can follow-up, and can assess their own learning; m) they can develop rational thought processes; n) learners can explore; o) they can build human relationships with their colleagues, teachers, and with experts; and p) they can creatively solve problems.

There are 408 general education Phrapariyattidhamma Schools, under the National Office of Buddhism, which is scattered throughout various regions of the country. There is a curriculum for lower secondary and high school, which uses the Basic Education Curriculum B.E. 2551 of the Ministry of Education. The Buddhist teaching focuses on studying the Principles of Buddhism in the Tripitaka scriptures. Nevertheless, the general education in the Pariyattidhamma schools must be adjusted to continue to meet the needs of society in this era, especially developing the teaching performances of the teachers (National Office of Buddhism, 2020).

Both the influences of the self-directed learning skills, which focus on learning in the 21st century, and the expectations for quality improvement in the General Education section of Phrapariyattidham Schools inspired the research team to develop an educational innovation called "An Online Program to Enhance Teacher Learning to Develop Students' Self-Directed Learning Skills." The development started with literature review related to self-directed learning skills from a wide range of perspectives. The knowledge gained was the foundation for the teacher's learning development. The teachers were expected to bring their learning outcomes and to direct them towards student development. In addition, the Research and Development (R&D) methodology was the key component of this study.

In a study by Sanrattana) 2018), it was pointed out that educational innovations, which are developed by the research and development methodology, are meant to help instructors improve the quality of their work. Teachers are expected to apply their knowledge and put it into practice, which will generate the power to work on the job more efficiently and effectively in accordance with the concept of "Knowledge + Action = Power." This concept led the researchers to believe that R&D be used to could create "An Online Program to Enhance Teacher Learning to Develop Students' Self-Directed Learning Skills" that could be used to develop teachers. Consequently, the teachers would be able to apply knowledge to effectively and comprehensively develop their students. The online program, which was the result of R&D, was offered to schools in random experimental locations. Therefore, it can be disseminated to benefit other schools with target populations across the country. In accordance with the principles of R&D, once an innovation has been researched and developed and that innovation has been tested in a representative experimental area with a target population, and once the results of the experiment have confirmed that an innovation has been effective according to the specified criteria, then the innovation can be widely distributed for the benefit of the population that has been the reference group in the research.

2. Research Objective

The objective of this research was to conduct research with Research and Development (R&D) methodology that would effectively generate "An Online Program to Enhance Teacher Learning to Develop Students' Self-Directed Learning Skills" according to the specified criteria. The designed online program was composed of a teacher's learning development project and a project to implement the teachers' learning outcomes to develop the students. These consisted of a module-based learning online instruction sets for self-learning, and an online instruction set to help teachers develop their students.

3. Research Hypothesis

The researchers reviewed the relevant literature to understand the academics' perspectives, and to create sets of online instructions. Next, the sets of online instructions were inspected and revised to ensure the validity of the research tools. The trials were conducted in the target school using R&D methodology, which is considered to produce beneficial educational innovations. Therefore, the hypothesis of the study was that the designed "An Online Program to Enhance Teacher Learning to Develop Students' Self-Directed Learning Skills" would be in accordance with the specific criteria: 1) the post-development test for teachers would meet the standard of 90/90, 2) the mean score of the teachers' post-test would be statistically significantly higher than before the development, and 3 (the students' mean score on the assessment of innovation skills after the development would be statistically significantly higher than before the development.

4. Research Methodology

4.1. Concepts and Procedures

In this research, as in the researches of Promrub and Sanrattana (2022), Chobjai and Sanrattana (2022), and Dhanapañño and Sutheejariyawattana (2022), is based on the Research and Development (R&D) methodology, according to Sanrattana (2018), who believes that the innovations created via the R&D process should be utilized in personal development so that the quality of work can be increased by using phenomena as the empirical evidence, which suggests that the need exists. Furthermore, there have been a lot of randomly new ideas and hypotheses on educational innovations recently. These ideas have centered on the assumption that teachers will use their learning outcomes (Knowledge) to help learners grow (Action), which will result in more competent work performance (Power). Concisely, it is founded upon the principle that "*Knowledge plus Action equals Power.*" or "*Make Them Know What to Do, Then Encourage Them Do What They Know,*" and "Link to On-The-Job Application." Another crucial stage was to analyze the literature on media literacy skills, which is seen as a necessary first step when gathering knowledge for the creation of online program for the projects. Each project had its specific manual for self-learning modules. Therefore, the procedure of the study began with a literature review in accordance with the R1&D1...R2&D2...R3&D3...Ri&Di patterns as described below:

R1&D1: Reviewing the Literature The research team studied the literature related to the following aspects of self-directed skills: definitions, influences, characteristics, developmental approaches, the developmental processes, and assessments. The knowledge acquired from this step was utilized in composing six online sets of instructions to be used for the teachers' learning development and one set of online instructions for the teachers to use in student's development.

R2&D2: The First Inspection for Defects The first inspection to search for defects was conducted for the sets of online instructions. The elements, which were inspected, included conciseness, usefulness, appropriate language, and the presentation of appealing content. Focus group discussion was conducted with 10 teachers at Wiwegthamprasitwittaya School, a non-experimental site.

R3&D3: The Second Inspection for Defects The second inspection to search for defects was conducted for the sets of online instructions. The elements, which were inspected, included conciseness, usefulness, appropriate language, and the presentation of appealing content. Focus group discussions were conducted at two non-experimental sites: Chantwittayakhom School (with 8 teachers) and at Wat Nongwaengwittaya School (with 7 teachers).

R4&D4: The Review of the Additional Literature The research team carried out further study to collect more about the assessment of self-directed learning skills in order to utilize information to create two research tools: 1) the test for teacher's learning based on the content of six manuals and 2) the student's information self-directed assessment.

R5&D5: The Trial of the Online instruction sets The online instructions sets were evaluated at Prapatsorn Wittaya School at Wat Si Nuan, a school that had been randomly assigned to represent the General Education Department of Phra Pariyatidhamma school under the Division of Buddhist Studies of the National Office of Buddhism. The experiment took place in the Second Semester of the Academic Year of 2021. The experiment was divided into two phases.

Phase 1: Conducting Project 1: The Teacher Learning Development Project The activities and schedule consisted of the following steps:

1. For the teachers in the experimental group, the objectives and research methods in Phase 1 were clarified, and then the teachers' knowledge was assessed prior to the experiment (pre-test). This step took two days.
2. The teachers began the self-study modules using the online instructions sets and the self-study programs. The online sets of instructions were available for teachers to download from the research team's website. The learning process had to take place without any involvement from the members of the research team or from anyone else. This process took a month.
3. The target teacher group cooperated to inspect the online instructions sets for any defects in order to make improvements, and then took the post-test. This step took two days.
4. The research team analyzed the post-test results and compared the results to the standard criteria of 90/90. After that, they made a comparative analysis of the average scores of the pre-test and the post-test by using a t-test dependent. This step took two days.

Phase 2 : The Implementation of the Teacher's learning outcomes to develop the students The activities and schedule in this phase consisted of the following steps:

1. For the teachers in the experimental group, the objectives and research methods for Phase 2 were clarified and then the teachers' knowledge was assessed prior to the experiment (pre-test). This step took two days.
2. The teachers began the self-study modules using the sets of online instructions and the self-study programs. The online instructions sets were available for the teachers to download from the research team's website. The learning process had to take place without any involvement from the members of the research team or from anyone else. This process took a month.
3. The target teacher group cooperated to inspect the sets of online instructions, which focused upon self-directed learning skills assessment, and to search for any defects in order to make improvements, and then they took the post-test. This step took two days.

4. The research team made a comparative analysis of the average scores of the pre-test and the post-test using a t-test dependent. This step took two days.

4.2. Research Tools

1. The Teacher's learning outcomes test : This assessment tool was used to evaluate the teachers' knowledge as a pre-test and a post-test and consisted of multiple-choice questions with four answers. The research team created this test using the content from the sets of the teacher's learning online instructions, which were composed of definitions, influences, characteristics, developmental approaches, developmental steps, and assessments. The test was an online form (Google Form). In addition, it was based on Benjamin S. Bloom's cognitive domain in The Revised Taxonomy (2001), which classifies thinking skills from low to high as follows: remembering, understanding, applying, analyzing, evaluating, and creating (Armstrong, 2010). Finally, the validity of the test was examined in the following manner:

1.1 The test validity was inspected by five experts, who were well-versed in the fields of curriculum, teaching, and measurements using Rovinelli and Hambleton's (1977) Indices of Item-Objective Congruence (IOC). The results indicated that every question had exhibited an IOC value of greater than 0.50 (Chaichanawirote & Vantum, 2017).

1.2 The test was tried out with 30 teachers at two non-experimental schools: Sarakhunwittaya School and Thaprahongthetpradit School. The analysis showed the following: 1) the index of difficulty of the questions had been between 0.20 - 0.80, and the power of discrimination had been between 0.20-1.00, which conformed to the specified criterion; 2) the KR - 20 coefficient was 0.91, which was greater than the specified criterion (equal to or greater than 0.70); and 3) the test difficulty had been equal to 44.44. Therefore, the test had exhibited the proper degree of difficulty.

2. The Students' self-directed learning skills assessment: The researcher constructed the assessment using a collection of characteristics from self-directed learning skills based on the perspectives of Atkinson (2015), Caruso (2011), Melaiikene (2015), Nucum, K, N (2019), and Vapulul (2019), and from a study of the concept of the assessment of the self-guided learning skills based on the perspectives of Khiat (2015), Stewart (2007), and Williamson and Seewoodhary (2007). The assessment form was an online form (Google Form) with 5-level rating scale: the most, very, medium, less, and the least. The validity of the assessment was examined as shown in the following steps:

2.1 The validity of the assessment form was inspected by five experts in the fields of curriculum, teaching, and measurement using Rovinelli and Hambleton's (1977) Indices of Item-Objective Congruence (IOC). The results indicated that every question had shown an IOC value of greater than 0.50 (Chaichanawirote & Vantum, 2017). Therefore, the questions could be used to assess the target group.

2.2 The Assessment Trial was conducted in a non-experimental school. There were 30 students from Wiwegthmprasitwittaya School, who participated in this step. Cronbach's method was employed to analyze the alpha coefficient of reliability. An analysis of the results demonstrated that the alpha coefficient of confidence for the entire questionnaire had been 0.97. The examination of each aspect revealed the following: 1) 'Awareness' had been 0.85, 2) 'Self-control' had been 0.69, 3) 'Self-assessment' had been 0.80, and 4) 'Learning desire' had been 0.92, 5) 'Learning strategy' had been 0.84, 6) 'Learning Activity' had been 0.85, and 7) 'Interpersonal communication' had been 0.89. The alpha coefficient of confidence had been greater than the specified criterion, which was equal to or greater than 0.70. Therefore, it was proven that the students' development assessment form could be utilized with confidence (UCLA: Statistical Consulting Group, 2016).

4.3. Data Analysis

1. The analysis and comparison of the post-experimental results from the teachers' learning outcomes had been in accordance with the 90/90 Standard. The first 90 represented the percentage of the mean scores, which had been obtained from the teachers' knowledge test. The second 90 represented the percentage of teachers, who had passed the test in accordance with all of the objective criteria (Yamkasikorn, 2008).

2. The t-test dependent statistic was employed to analyze the data and to compare the results from the teacher's learning outcomes and the student's self-directed learning assessment for both the pre-experimental test and the post-experimental test.

5. Research Results

"An Online Program to Enhance Teacher Learning to Develop Students' Self-Directed Learning Skills" was comprised of two projects, each with its own instructions, and was based on the study's findings from the R1&D 1 stage.

1. The development of the teachers' learning project: There were 6 sets of instructions for teacher self-learning. Each set presented the perspectives of academics and agencies found in the relevant literature as follows:

1.1 The instructions for the definition of self-directed learning skills presented perspectives from Brookfield (1985), Garland (1985), IGI Global Disseminator of Knowledge (n.d.), Meredith (1989), Mezirow (1985), Mocker and Spear (1982), Petro (2017), Stefanou, Perencevich, DiCintio, and Turner (2004), Tekkol and Demirel (2018), and Weimer (2010).

1.2 The instructions for the influences of self-directed learning skills presented perspectives from Alternatives to School (n.d.), Andriotis (2017), Green (n.d.), Gutierrez (2017), Holz (2017), Self-Directed Learning (n.d.), Timpau (2015), and Western Academy of Beijing (2017).

1.3 The instructions for the characteristics of self-directed learning skills presented perspectives from Atkinson (2015), Caruso (2011), Melaikiene (2015), Nucum (2019), and Vapulus (2019).

1.4 The instructions for the developmental approaches of self-directed learning skills presented perspectives from Ark (2016), Briggs (2015), Centre for Teaching Excellence (n.d.), Cobb (n.d.), Cox (2019), Design Your Homeschool (n.d.), Dickinson (2018), Professional Learning Board (2018), and Weimer (2010).

1.5 The instructions for the developmental processes of self-directed learning skills presented perspectives from Brookes (2019), Dobbs (2017), and Harvey (2019).

1.6 The instructions for the assessment of self-directed learning skills presented perspectives from Khat (2015), Stewart (2007), and Williamson and Seewoodhary (2007).

2. Implementation of teachers learning outcomes for the student development project: There was a set of instructions for practicing with the explanation and the list of essential topics on the following: 1) The Expected Self-Directed Skills Qualifications in Students, 2) The Developmental Guidelines for Self-Directed Skills, and 3) The Developmental Processes of Self-Directed Skills. The final part of the instructions was attached to the self-assessment for teachers and focused on the implementation of the developmental approaches and the developmental steps, feedback about the flaws in the instructions, and reflections from the teachers after completing the work.

Remarks:

- 1) Please refer to every manual written in Thai at: http://www.mbuisc.ac.th/phd/A_R&D%20Modules/PhaladLek.pdf
- 2) Please refer to the teacher practice level assessment form written in Thai at: <https://bit.ly/3HN9mcS>
- 3) Please refer to the teacher's learning outcome test written in Thai at: <https://bit.ly/3A1Iw9>
- 4) Please refer to the development assessment form self-directed learning skills of students written in Thai at: <https://bit.ly/3NmIvWi>

The employment of R2&D2, R3&D3, R4&D4 and R5&D5 generated the following: 1) six sets of online instructions for the development of teachers' learning outcomes; 2) a set of online instructions for the implementation of learning outcomes for student development; 3) the teacher's learning test; and 4), the student self-directed learning assessment form. Moreover, the field experimental research, which adopted the pre-experimental research with a one group pre-test/post-test design, was conducted. The online instructions were evaluated at Prapassornwithaya, which is a school that represented the General Education Phrapariyattidhamma Schools, under the National Office of Buddhism. An experimental research model, which was designed as a one group pre-test/post-test, consisted of an experimental group of 25 teachers and 146 students. The research findings

were consistent with the hypothesis that “An Online Program to Enhance Teacher Learning to Develop Students' Self-Directed Learning Skills” was certified as beneficial according to the specific criteria. The details of the findings are discussed below:

1. Regarding the teacher's learning outcomes, the post-experimental test results conformed to the standard of 90/90. The first 90 represented the percentage of the mean post-test scores, which was 33.52 points out of 36 or 93.11 percent, and which was higher than the specified criterion (90). The latter 90 represented the percentage of the teachers, who had been able to complete all of the objectives. The results showed that 95.33 % of the 25 teachers had been able to pass all of the objectives on the exam. The number was determined to be higher than the specified criterion (90).
2. The results of the pre-experimental test mean score from the 25 teachers had been 28.56, and the standard deviation had been 2.77, while the post-experimental test mean score had been 35.52 and the standard deviation had been 1.87. After the data had been analyzed using a t-test dependent, the mean score of the post-experimental test was found to be statistically significantly higher than the mean score of the pre-experimental test at 0.05, which is shown in Table 1.

Table 1 :The t-test dependent results when comparing the teachers' learning outcomes before and after the experiment

Tests	Sample sizes	Means	Standard Deviations	t
Before	25	28.56	2.77	17.7019*
After	25	33.52	1.87	

*p < 0.05

- 3) The assessment results from self-directed learning skills with the 146 students before the experiment illustrated that the mean had been 3.49 with a standard deviation of 0.14. Meanwhile, the results from the assessment after the experiment had shown a mean of 4.35 with a standard deviation of 0.24. After the data had been analyzed using a t-test dependent, the mean score from the post-experimental assessment was found to be statistically significantly higher than the mean score from the pre-experimental assessment at 0.05, which is shown in Table 2.

Table 2: The t-test dependent results when comparing the students' information literacy skills before and after the experiment assessments

Assessments	Sample sizes	Means	Standard Deviations	t
Before	146	3.49	0.14	36.366*
After	146	4.35	0.24	

* p < 0.05

6. Discussion

The created program, “An Online Program to Enhance Teacher Learning to Develop Students' Self-Directed Learning Skills” was developed from a study of the literature related to self-directed learning skills on the topic of definitions, influences, characteristics, developmental guidelines, developmental steps, and assessments. The body of knowledge from the literature review was developed into 6 sets of online instructions for teacher learning and 1 set for the teachers to use as a guideline for student development. The findings of the study demonstrated that “An Online Program to Enhance Teacher Learning to Develop Students' Self-Directed Learning Skills,” which had resulted from utilizing R&D methodology, had allowed the post-experimental test results in the teacher's learning outcome to meet the standard of 90/90. Moreover, the learning outcome after the experiment had been statistically significantly higher than before the experiment. It also showed that after the experiment, the self-directed learning skills assessment of the students had been statistically significantly higher than before the experiment. The definitions of self-directed skills in late 20th century and in 21st century are similar, but the development approaches differ because the 21st century context consists of disruption, globalization, digitalization, a surge in information, and the scenarios rising from more unknown problem that are bound to cause

a lot of change. Therefore, the use of R&D methodology in this research as a tool for innovation development has resulted in innovations that are in line with the changing social conditions. As Ross (2021) stated, R&D is not solely about creating new products, because it can be used to strengthen an existing product or service with additional features. It showed that the online program, which was the result of this research, could be disseminated to 408 nationwide Phrapariyattidhamma Schools in the General Education section, which are affiliated with the National Office of Buddhism. In addition, according to the principles of R&D, once an innovation has been researched and developed and that innovation has been tested in a representative experimental area of the target population, and once the results of the experiment have confirmed that the innovation is effective according to the specified criteria, it means that the innovation can be widely distributed for the benefit of the population that is the reference group in the research (Sanrattana, 2018).

In this study, the research team placed emphasis on the idea that the intention for the educational innovations, which have been developed through the research and the developmental process, is that the innovations be used to develop teachers to improve the quality of their work. (The main task of the teacher is to manage teaching and learning to develop students.). Presently, there are many principles, concepts and theories that are considered innovative in education. Given these educational innovations, it is expected that if teachers have knowledge and they are motivated to convert the knowledge into practice, then the power to perform their duties in a more efficient manner will be generated. This concept is consistent with findings from Speck (1999) and Seyfarth (1999), who stated that to conduct educational administration, teachers must be educators and leaders in teaching and learning. It also in line with the concept of teacher professional development that was put forth by Gusky (2000) and Hoy and Miskel (2001), who agreed that in teacher development, the students must be considered with respect to the benefits that impact the ultimate goal of education. Furthermore, this is consistent the perspective of Narinto (2019), who identified that the development of teacher quality has always been an interest of educational reform. In the era when education is giving priority to 21st-century educational reforms based on rapidly changing social conditions, global society has become a society of knowledge or a society of learning. The model is in line with the world's current and future changing trends. In the 21st century, when educational changes are becoming a top priority, the world civilization has evolved into a learning society and a knowledge society. The model harmonizes with the present and future evolving patterns in the world. Rakwichtkul (2017) stated that teacher professional development is continuous learning. Therefore, professional development activities must be designed to integrate with the work that is being done. The teachers must improve their teaching so that the development of the students' learning potential will be positively affected.

To conform with the times and with technological advancements, a focus has been placed on the creation of online programs. Instead of a program that utilizes printed media, online programs and online media are more convenient and cost-effective to employ in a variety of situations. As noted by Wannaprapha (2017), social media is a tool for education, which enables people to communicate effectively, and which plays a role in education both in teaching and in learning & management. Teachers can use social media to benefit the education system via formal education and informal education. In the future, it is most likely that social media will help learners to explore the unlimited knowledge of time and space and will help to build self-directed learning skills for students more frequently than in the past. This is consistent with the view of Damjab (2019), who stated that current learning focuses on hands-on activities. Therefore, taking action and being self-directed should be encouraged by relying on the combined use of logical thinking skills and innovation & information technology.

7. Recommendations

As mentioned above, in the research and development portion of "An Online Program to Enhance Teacher Learning to Develop Students' Self-Directed Learning Skills," the research team places emphasis on utilizing the knowledge that is widely available on the Internet in order to further the development of teachers and students. The lessons, obtained from the research, revealed that the research method had assisted in the development of a variety of 21st-century abilities, such as: information literacy skills, media literacy skills, ICT (information, communications, and technology) literacy skills, cross-cultural skills, and productivity skills. Therefore, it may be feasible to establish another concept that can be regarded as a 21st century skill, which can be called "**R&D Skills**"

or "**R&D Thinking Skills.**" It may be a study that adapts the concepts from the R&D methodology, which were used in this research, and makes them suitable for classroom teaching.

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Appendix

The student's Self-Directed Learning Skills Self-Assessment form used in the research.

Self-Directed Learning Skills Characteristics	Self-Assessment levels				
	5	4	3	2	1
Awareness					
1. I am responsible for learning by myself.					
2. I can plan and set my own learning goals.					
3. I can identify my own learning needs.					
4. I can choose for myself the best learning method.					
5. I can maintain my motivation for learning.					
Self-control					
6. I can decide to learn according to my own needs and interests.					
7. I know my abilities					
8. I believe in my abilities					
9. I manage my time very well.					
10. I can prioritize my work.					
Self-Evaluation					
11. I can assess my basic learning skills.					
12. I am inspired by the success of others.					
13. I always check myself whether I have achieved my learning goals or not.					
14. I find both successes and failures motivating me to learn more.					
Desire for learning					
15. I want to learn new things					
16. I enjoy learning new information.					
17. I am always open to new ideas.					
18. I learn from experience and environment.					
19. I like to gather facts before making a decision.					
20. When I face an unresolvable problem I will ask for help					
Learning Strategies					
21. I am skilled at acquiring new knowledge through creative problem- solving learning.					
22. I like to learn as a group to exchange learning.					
23. I have found that having a friend as a mentor can help me study successfully.					
24. I find that concept maps are an effective method of learning.					
25. I have found that participating in teaching is more effective than listening to lectures.					
26. I have found that modern educational technology has greatly improved my learning process.					
Learning Activities					
27. I can choose an appropriate learning technique/activity.					
28. I like to take breaks between classes.					
29. I like to use concept maps to understand a wide variety of information.					
30. I can choose the right technology medium.					
Interpersonal communication					
31. I am always open to the opinions of others.					
32. I find it easy to work with others.					
33. I have always been successful in verbal communication.					
34. I can express my thoughts through writing effectively.					
35. I find it challenging to try to learn with a wide variety of people.					
36. Interacting with others has helped me develop deep understanding and learning.					