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The Effect of Project-Based STEAM Acquire on Student Creativity in Science Learning During the Pandemic Period

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Abstract: The reason for this think about was to look at the impact of Project-based STEAM acquisition on college inventive considering and basic considering aptitudes. The ponder utilized a quasi-experimental plan using a nonequivalent pretest-posttest control gather plan. The populace for ponder were all understudies in Sunan Ampel State Islamic University, Surabaya whereas the test utilized included one department of Biology for the test course and one department of Engineering, utilized as the control lesson. The purpose of this study is to provide an overview in the form of a description of the implementation of STEAM-based acquisition for children aged 5-6 years at Al-Azhar Syifa Budi Surakarta Kindergarten. The information collected was at that point analyzed utilizing the ANOVA test. The pjBL-based STEAM acquisition had a critical impact on understudies' imaginative considering abilities (P 0.000 < 0.005; Fcount = 25.551). The pjBL-Based STEAM acquisition had a critical impact on understudies' basic considering aptitudes (P 0.003<0.05, Fcount=9,401). So, PjBL-Based STEAM acquire can be utilized as elective acquire to enable 21st-century abilities.

Keywords: Creative thinking; Critical thinking; Pjbl

Introduction

Currently in the 21st century which is a century with very rapid development of science and technology almost all over the world or globally. This triggers an increase in competition or very tight competition between countries which has an impact on globalization in the world. To be able to compete in the 21st century, a new caliber is needed called the 21st century caliber. The 21st-century caliber can be distinguished through education. Educators and students expand their capabilities with technology to enhance the quality of their future careers and social lives (González-Pérez & Ramírez-Montoya, 2022). In this rapidly changing world, creativity is one of the things that determines one's excellence. A person's success is determined by his creative quality in solving problems, both big and small problems. The importance of the aspect of creativity to animate humans makes the study of creativity an important topic for various groups, ranging from public policymakers, scientists, and researchers, to practitioners. But in reality, creativity data in Indonesia is still relatively low (Akpata, 2022).

Especially since the Covid-19 pandemic hit, acquirers in Indonesia are experiencing an education crisis, so acquires are carried out by acquirers online. Acquire online is an effort to obtain activities that prohibit universities from conducting face-to-face meetings, obtaining them through the internet using various platforms such as Zoom meetings, google classrooms, and video calls via WA. In addition, the online acquisition is also interpreted as an acquisition activity organized by schools where students and teachers are in separate locations so that they require the connecting media needed to support the acquisition process (Birkmeyer et al., 2020).

Currently, online acquisitions can be used as a solution to make remote acquisitions when a disaster occurs or conditions that do not allow direct acquisitions to be carried out. Acquisition activities online pressure the distribution and distribution of information which makes it easier for universities to get better quality

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acquisitions. This acquisition also makes it easier to carry out acquisitions from wherever and whenever they are made (Miozzo et al., 2016).

Currently, online acquisitions are increasingly popular because they can provide more flexible services so they provide many advantages in their implementation. Online acquisitions aim to provide quality acquisition services and be able to reach broad targets. Remote acquiring or online earning can provide an atmosphere of face-to-face acquisition via virtual (Rafiq et al., 2021). Improving the quality of education according to the needs of the 21st century, especially in early tertiary education is an application of acceptance that can develop the various calibers possessed by early tertiary institutions. The development of aspects of student development to think creatively and critically has 6 aspects which include aspects of Religious and Moral Values (NAM), social-emotional, cognitive, language, physical-motor, and art. The development of these six aspects must be developed in a basic and integrated manner so that children have various qualities that can respond to future challenges (Cebrián et al., 2020).

PjBL-based STEAM is the basis for obtaining a method so that in the acquisition process it teaches skills that refer to the development of a comprehensive world of technology. The PjBL-based STEAM method can be used in student learning by collaborating on the relationship between science and everyday life by integrating components in learning themes and of course with practicums or projects. Based on the explanation above, this article was written to find out how to apply the steam acquire model to early tertiary education through online acquisition (Öz et al., 2021).

Two major obstacles that lecturers must overcome to apply STEAM education in their classrooms. The first obstacle is an integrative approach which requires content from several topics to be applied simultaneously. The second barrier is transdisciplinary education (lecturers must teach content outside their comfort zone or speciality). The following challenges were mentioned by in-service lecturers who are currently implementing STEAM education in their classrooms: a lack of time for participatory planning, a lack of time for instruction, an insufficient educational structure and organization, difficulty evaluating STEAM accomplishments, a limited number of resources, and insufficient lecturers' preparation (pre-service education should focus more on inter-disciplinarity while in-service (Wannapiroon & Pimdee, 2022).

Aside from the constraints, lecturers face several challenges in STEAM implementation, including curriculum challenges in universities, structural challenges, concerns about implementation to college and how to assess, support from fellow lecturers on the course team, and challenges in adjusting technological aspects (Mardiana, 2020). STEAM implementation is considered difficult to implement if there are no clear guidelines prepared by qualified experts. To ensure the implementation of STEAM teaching related to the problems encountered, a needs analysis of the STEAM teaching strategy must be performed (Awang et al., 2020).

Furthermore, all research yield indicated that STEAM-integrated project-based acquire might be used to enhance colleger's 21st-century caliber (Zayyinah et al., 2022). Due to the COVID-19 pandemic, the most recent difficulty in education is converting the educational system to an online one. It is necessary to assess once more how acquisition with STEAM-integrated project-based acquisition, which is known to enhance 21st-century abilities, was affected acquire during the COVID-19 pandemic. Project-Based Acquire that incorporates STEAM is envisioned as an alternative to traditional classroom settings, both offline and online (Puspaningtyas et al., 2023).

During the new normal or post-pandemic period, there is a need for the recovery of acquired innovations, so that colleger can rise and recover faster to have normal motivation and concentration on acquisition. Innovation can not only be done through acquiring models but also through the development of teaching materials. The integration of STEM approaches in the development of teaching materials in courses is one of the efforts to condition student-centered acquire oriented towards achieving 21st-century competencies. At this time the facts show that: ccolleger scritical thinking caliber is still relatively low in the field of science. Modern education must be able to contribute to the life of a productive, creative, and innovative society through acquiring approaches that develop thinking and problem-solving caliber.

Method

The study used a quasi-experiment design with a non-equivalent pretest-posttest control group research design. The research population is a college student of the Faculty of Science and Technology for the 2020/2021 academic year; Research data were obtained using essay writing tests and observation sheets. The creative thinking caliber assessment rubric used is a modification of Bosch. Data analysis techniques through pre-requisite tests and hypothesis tests using the help of the IBM SPSS Statistics 22 program. The prerequisite test uses the normality test and homogeneity test, while the hypothesis test uses the Anacova test ($\alpha = 0.05$).

Table 1. Creative Thinking Criteria

Creative Thinking Criteria	Class Interval
Not Creative	10-20
Less Creative	21-40
Quite Creative	41-60
Creative	61-80
Very Creative	81-100

Table 2. Critical Thinking Criteria

Predicate	Number Range
Excellent	86-100
Good	71-85
Enough	56+70

Result and Discussion

Based on the yield of the analysis, it can be seen that the yield of the Anacova test of creative thinking caliber obtained a Fcalculate value of 35.551 with a sig value of 0.000 < 0.05. This shows that the STEAM PjBL acquire model has a significant effect on the college's creative thinking caliber. The yield of the Anacova test of creative thinking caliber a shown in the following Table 3.

Table 3. Anacona Test Yield of Creative Thinking Calibre

Source	Type III Sum of Squares	D F	Mean Square	F	Sig
Corrected Model	8729.689	2	4369.845	39.512	.000
Intercept	16269.006	1	16269.006	147.105	.000
Pretest	3410.689	1	3410.689	30.840	.000
Type	3931.691	1	3931.691	35.551	.000
Error	6746.248	61	110.594		
Total	328806.000	64			
Corrected Total	15485.938	63			

The yield of the analysis of pretest and posttest data also showed that there were differences in creative thinking caliber between the control class and the experimental class. The percentage yield of creative thinking caliber a presented in the following Table 4.

Table 4. Percentage Pretest and Posttest Creative Thinking Calibre Yield

Cubbyhole	Pretest experiments (%)	Postest experiment (%)	Pretest control (%)	Postest control (%)
Not creative	9.30	0	9.3	0
Less creative	50	0	65.60	3.10
Quite creative	37.50	6.35	25	43
Creative	3.10	40.60	0	53.10
Very creative	0	53.10	0	3.10

Based on the data in the table above, it can be seen that the percentage of college who reached the cubbyhole of being able to think very creatively in the experimental class was 53.1%, while the number of colleges who were included in the very creative cubbyhole at the end of acquire in the implementation of scientific acquire was 3.1%. Similarly, the average corrected score of creative thinkingcalibere in classes with the application of PjBL-based STEAM acquire is also known to be higher at 77.9 compared to classes that apply scientific acquire at 62.02. This shows that the PjBL-based STEAM acquires potential model is greater in getting better colleger' creative thinking caliber compared to the implementation of theoretics and textual reading acquire.

Furthermore, the yield of the Anacova test on critical thinking caliber obtained a Fcalculate value of 9.401 and a sig value of 0.003 smaller than 0.05. This shows that there is an influence of PjBL-based STEAM acquisition on the colleger's critical thinking caliber. The yield of the Anacova test of critical thinking caliber can be seen in the following Table 5.

Table 5. Anacova Test Yield of Critical Thinking Calibre

Source	Type III Sum of Squares	DF	Mean Square	F	Sig
Corrected Model	9754.544	2	4877.272	65.448	.000
Intercept	5046.959	1	5046.959	67.725	.000
Pretest	4906.904	1	4906.904	65.845	.000
Type	700.570	1	700.570	9.401	.003
Error	4545.815	61	74.522		
Total	303341.000	64			
Corrected Total	14300.359	63			

Furthermore, based on the yield of the pretest and posttest data analysis, it can be seen the distribution of the level of becoming better in the collegers critical thinking caliber from experimental and control classes. The percentage of critical thinking caliber categories can be seen in the following Table 6.

Table 6. Result Postest and Pretest Score Percentages on Critical Thinking Calibre

Cubbyhole	Pretest experiments (%)	Posttest experiment (%)	Pretest control (%)	Posttest control (%)
Excellent	0	0	0	0
Good	0	21.80	0	6,25
Enough	0	46.80	0	34.30
Less	100	21.80	100	59.30

Based on the data in the table above, it can be seen that in acquire that implements PjBL-based STEAM, the percentage of college who achieve critical thinking

caliber in the good cubbyhole is 21.80%; while in the control class taught with scientific acquire was only able to reach the good cubbyhole of 6.25%. The integration of the two acquire models certainly has several advantages and has great potential in empowering the collegers creative thinking caliber. Activities carried out in STEAM-PjBL acquire refer to project-based acquire stages with provisions also integrated with aspects of STEAM. The steps include determining fundamental questions, preparing project planning, preparing schedules, monitoring, assessing yield, and evaluating.

The average corrected score of critical thinking caliber in classes that apply PjBL-based STEAM acquire is also known to be higher at 70,996 compared to classes that apply scientifically acquire at 63,410. This shows that the PjBL-based STEAM acquire model is higher in getting better colleger' critical thinking caliber compared to the conventional science-based acquire model. The first step in acquiring STEAM-PJBL is to determine basic questions that can assign colleger in solving problems and carrying out an activity. The topics used are by the circumstances that exist in the real world. Problems used in a project-based acquisition must be in the form of contextual problems that can train and become better colleger's creative thinking caliber through exploring and expressing mathematical ideas in solving a problem. Meanwhile, questioning activities can become better critical thinking caliber because these activities can require colleger to argue for questions and can provide deductive or inductive conclusions to the given problem (Nwosu & Vorster, 2021).

The second step is to develop a project plan that will be implemented collaboratively between teachers and the college. This planning involves rules in designing the project and carrying out activities as well as determining easily accessible tools and materials for the needs of the project. The caliber to think creatively can involve the caliber to design in making changes and becoming betters to obtain new ideas (Amelia et al., 2021). In step three, colleger and teachers collaboratively schedule activities in project creation. Activities in preparing this schedule are in the form of making timelines and deadlines. At this stage, the college is guided to use the right way to complete the project. Furthermore, in step four, the teacher monitors student progress and facilitates college during the project creation process. For monitoring, teachers must record all student activities during project creation. This is done so that colleger are more guided and directed and precise during the project-making process.

The fifth step is to test and assess the yield by the way representatives of each group communicate the yield of their project in front of the other groups. When the college communicates such as expressing opinions, discussing, and understanding problems in community life, the college can gain a better understanding of the acquired material. Testing the yield can help the college to bring out creative thinking caliber flexibly (flexible). Thus, each student can provide a different thinking yield in solving a problem, because colleger are required to think originally in presenting the yield of their projects.

Thus, at this evaluation stage colleger are equally required to think critically in assessing the positive and negative sides of the project that has been made. The application of PjBL-based STEAM can be said to have developed colleger's creative and critical thinking caliber because at each stage of acquiring colleger need cooperation, and communication between friends and are skilled in solving problems and being responsible (Valente et al., 2022)

The quality of a country's education can not only be assessed through increasing the avail caliber of adequate educational facilities and infrastructure, but getting better the quality of education should also be followed by strengthening colleger' social caliber, critical and creative thinking, communicating, collaborating, and must be able to prepare college to compete in the 21st-century era towards an independent society by developing innovation. This is in line with the four competencies that 21st-century colleger must have, including creativity and innovation, critical thinking and problem-solving, communication caliber, and collaborating to build and prepare colleger for a dynamic world life. Furthermore, the purpose of education is to prepare colleger to have analytical calibre, problem-solving calibre, and critical thinking calibre so as to encourage colleger' higher-order thinking calibre (Utomo et al., 2022). In supporting the achievement of these goals, it must be followed by curriculum development as an important element in the implementation and achievement of educational goals. The development of the curriculum is carried out following the needs and developments and changes of the times.

The demands of educational interests not only emphasize the acquire process only on cognitive aspects, but the educational process must also be able to balance 3 main aspects to prepare colleger as a generation that is ready to face the challenges of the 21st century. With the curriculum currently applied in Indonesia, the 2013 Curriculum is able to support developing three aspects, namely attitudes, knowledge, and calibre which are then continued with an independent curriculum that requires colleger to think critically and creatively. With the implementation of the 2013 curriculum, it is expected to be able to develop colleger who have characteristics through the development of these 3 aspects.

Referring to the Regulation of the Minister of Education and Culture No. 20 of 2016 concerning Primary and Secondary Education Competency

Standards states that graduate competency standards are criteria for graduate qualification competencies which include attitudes, knowledge, and expertise. Basically, each student has competencies that are carried from birth, but the level of competence of each student is different. In order to achieve graduate competency standards, the acquire process does not only focus on delivering material. The acquire process must involve colleger playing an active role in acquire and colleger are able to have competence in completing a project. Therefore, teachers play an important role in determining and choosing the right acquire models and media. One of the acquire models that teachers can apply and is appropriate in supporting the achievement of these competencies is the application of a project-based acquire model.

The project-based acquire model is one of the acquire models that emphasizes the calibre of colleger to complete projects either individually or in groups. Project-based acquire emphasizes student involvement in the task given and requires colleger to collaborate and learn independently. Project-based acquire models can provide meaningful acquire experiences for colleger and can require colleger to be able to develop various calibre they have. In addition, colleger can be actively involved in the process of inquiry and decision making, thus getting better colleger' critical thinking thinking. Project-based acquire is able to encourage the development of colleger' scientific thinking processes and colleger' calibre in carrying out a process (LaForce et al., 2017). With the development of scientific thinking process calibre, it is also able to be a driver for the development of colleger' scientific way of thinking. With this process, colleger are expected to be able to provide problem solutions with the help of their scientific thinking by asking various questions, discussing ideas with various questions, making observations and making predictions, conducting experiments, collecting and analyzing data, and drawing conclusions.

The application of a project-based acquire model that emphasizes thinking and working activities in groups, can become better colleger' scientific thinking power so as to create innovative thinking power, become better cognitive calibre, question calibre, develop colleger' social calibre, encourage colleger to love nature, develop scientific calibre, and develop scientific and critical thinking calibre. The project-based acquire model can be applied to every field of science and acquire materials, especially science acquire.

Natural science is basically acquir that emphasizes products and processes. Through science acquire design that can encourage active colleger, it can be one of the drivers of developing 4 competencies or 4 calibre that are emphasized in 21st century acquire. Through several appropriate approaches, science acquire is expected to be able to encourage colleger to master science and technology, think logically and critically, argue rationally, act comprehensively, and be able to solve various problems in real life. However, if traced further, science acquire in Indonesia in its implementation has not used various innovative acquire designs as expected. In general, science acquire is still carried out with lecture and question and answer methods only (Schmidt et al., 2015). Colleger only memorize the subject matter, but the experimental process is not applied directly to colleger to develop process calibre related to developing 21st century calibre.

Previous research written by van Laar et al. (2020), the 21st century is a century marked by the rapid development of science and technology. In the face of the 21st century, humans must have 4C calibre. In developing 4C calibre can be through a acquire in which contains STEAM. However, the reality is that there are still ECCE institutions that apply classical acquire so that they are considered less optimal in providing stimulation of 4C calibre for children from an early age. The purpose of this study is to provide an overview in the form of a description of the implementation of STEAM-based acquire for children aged 5-6 years at Al-Azhar Syifa Budi Surakarta Kindergarten. This study used a type of descriptive qualitative research. Data collection techniques consist of observation, interviews, and documentation. Data validity techniques use data source triangulation and method triangulation. Data analysis techniques consist of data collection, data reduction, data presentation, and conclusion.

The yield of this study shows that the implementation of STEAM-based acquire for children aged 5-6 years at Al-Azhar Syifa Budi Surakarta Kindergarten has been well organized (Tabiin, 2020). This can be seen through the stages of planning, implementation, and evaluation. At the acquire planning stage, they include: Making independent teaching modules, preparing tools and materials, Invitation, Provocation, Preparing documentation and evaluation tools. Then, the acquire implementation stage includes: initial activities, perception, provocation, core activities, closing, evaluation. The evaluation carried out by the teacher 1 week after the activity was carried out was using the types of assessments (Swaran Singh et al., 2017). Checklist, Work Yield, Anecdotes, Serial photos. Based on the yield of the research and discussion of the thesis above, it can be concluded that the implementation of STEAM-based acquire at TKAl-Azhar Syifa Budi Surakarta in children aged 5-6 years has been well organized and maximized.

STEM learning can encourage learners to develop 21st century literacy and is considered an interdisciplinary approach that can encompass the entire educational process. Nevertheless, learners are still less

motivated in STEM learning. Art integrated STEM learning is used as a solution to increase student participation and motivation in learning (Yang & Baldwin, 2020). STEAM learning is important because art practice on STEAM can encourage independent learning, social responsibility, and creative problem solving. Art on STEAM can also facilitate integrated learning in a transparent manner that provides deeper understanding.

Cross-disciplinary thought processes can support students' development of transdisciplinary thinking. Learning with STEAM learning integrates learning materials in a transdisciplinary manner by involving creativity. Transdisciplinary-integrated learning is considered important in the process of solving complex problems. STEAM learning has begun to be known in Indonesia. Some teaching practitioners are starting to implement STEAM learning in the classroom. Education observer from the Center of Education Regulation and Development Analysis. Margot & Kettler (2019), said that the curriculum must focus on improving basic skills and soft skills in accordance with the times so that curriculum development must begin to be STEAM-based. In addition, teachers are one of the most important keys in educational success, including in the implementation of STEAM. Therefore, there is a need for research that examines the practice of implementing STEAM learning by teachers and the challenges faced by teachers in implementing STEAM.

In addition to positive perceptions, teachers also expressed concern about their readiness to implement STEM in the classroom even though teachers agreed on the various benefits of STEM learning, especially in developing 21st century skills. Teachers revealed that challenges faced in STEM implementation include curriculum challenges, structural challenges, concerns about students, concerns about assessment, support from fellow teachers and challenges in integrating aspects of technology (Quigley et al., 2020).

Functional literacy is one of the backgrounds of STEAM learning. Learners need to master literacy from basic disciplines such as transferring interdisciplinary knowledge with higher-order thinking skills. Therefore, integration in STEAM can help students to be able to develop their literacy skills. Another theory underlying STEAM education is the theory of holistic learning (Pasani & Amelia, 2021). One of the goals of STEAM education is to facilitate lifelong learning. Holistic teaching is influenced by one's environment or influences which will help determine what one will do with the environment or objects already provided. This causes different views for each individual so that holistic learning cannot be given equally to learners. Therefore, learning activities need to facilitate students to be creative in building their knowledge and abilities.

Conclusion

Based on the final yield of the study, it can be seen that PjBL-based STEAM acquire has a significant effect on the creative thinking calibre of colleger with sig scores. by 0.000 smaller than 0.05 and Fcalculate by 35.551. PjBL-based STEAM acquire has a significant effect on colleger' critical thinking calibre with a GIS value of 0.003 smaller than 0.05 and a Fcalculate value of 9.401. This is because the integration of STEAM PjBL together can be a acquire innovation that can bring up creative and critical ideas and solutions, making it easier to solve a problem. Therefore, it is highly recommended to educators to use the STEAM PjBL acquire model as an innovative acquire model in schools.

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Conceptualization: Dewi Suliyanthini, data curation: Fajar Yulianur, funding acquisition: Dewi Suliyanthini, methodology: Fajar Yulianur, visualization: Fajar Yulianur, writing–original draft: Dewi Suliyanthini, writing–review & editing: Dewi Suliyanthini, Fajar Yulianur.

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