Journal Sport Area
http://journal.uir.ac.id/index.php/JSP
Vol. 7. No. 3. December, (2022)

Self-regulated learning based-STEM model: How it impacts students' self-directed learning in physical education classes

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Received: 17 September 2022; Accepted 12 December 2022; Published 17 December 2022
Ed 2022; 7(3): 465-472

ABSTRACT

The low level of self-directed learning among students is a problem in this study and the limited research on Science, Technology, Engineering, and Mathematics-based Self-Regulated Learning in physical education is a gap in this research. Science, Technology, Engineering, and Mathematics (STEM) based on Self-Regulated Learning (SRL) is an alternative learning model in Physical Education. The purpose of this study was to determine the effect of application Science, Technology, Engineering, and Mathematics based Self-Regulated Learning to develop self-directed learning. This study used quasi-experimental method with a nonequivalent control group design and sampling used purposive sampling technique. The participants in this study were students VIII grade. Research was conducted in SMP Laboratorium School UPI with online learning and Limited Face-to-Face Meeting. The instruments of this study used the Self-Rating Scale of Self Directed Learning (SRSSDL). After the sample had completed the treatment, the results of data analysis showed that directed learning aspect was 0.027 with the criterion value (Sig.) = 0.05. Regardless of the results, this is supported by empirical evidence from student behavior, learning, and task making. They showed the development of students' abilities in the learning process did not depend on teachers, friends, class conditions and others. It can be concluded that implementation of Science, Technology, Engineering, and Mathematics (STEM) based on Self-Regulated Learning (SRL) has an effect on develop self-directed learning. This research contributes to learning innovation in physical education, so that teachers can apply this model on an ongoing basis to develop self-directed students. Future research needs to be done, for example trying to apply this model to develop other potentials in students such as motivation, cooperation, or responsibility.

Keywords: STEM; SRL; self-directed learning; physical education

https://doi.org/10.25299/sportarea.2022.vol7(3).10550

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How to Cite: Gumilang, E. S., Martini, T., & Budiana, D. (2022). Self-regulated learning based-STEM model: How it impacts students' self-directed learning in physical education classes. *Journal Sport Area*, *7*(3), 465-472. https://doi.org/10.25299/sportarea.2022.vol7(3).10550

Authors' Contribution: a – Study Design; b – Data Collection; c – Statistical Analysis; d – Manuscript Preparation; e – Funds Collection

INTRODUCTION

Physical education is defined as education through and from physical activity (Zalech, 2021). Physical education is an integral part of overall education which is structured systematically through the provision of experience of movement tasks to assist the development and growth of comprehensive individuals. Thus, physical education has a goal that is in line with the purpose of education in general, namely to make a very valuable and inspiring contribution to the welfare of human life (Corbin, 2021). The meaning contained in physical education is not just physical education or physical activity but is more broadly related to the overall educational goals and contributes to individual life. The implementation of physical education must lead to the overall educational goals. In connection with this, a learning model is needed that is following the objectives of physical education where individuals are required to be able to survive in this modern era (Corbin, 2021). The situation that has changed humans both in life and work is known as the Internet of Things (IoT) which means the world is introduced to machines and data that can be accessed by anyone and anywhere and connected to fellow humans (Cojocaru et al., 2022). An interdisciplinary of learning model between science, technology, engineering, and mathematics is called Science, Technology, Engineering and Mathematical model (STEM) (Saraç, 2018; Sagala et al., 2019; Sari et al., 2020). This model applies problem-solving-based learning with mathematics in the context of designing technology as a form of problem-solving and deliberately places scientific inquiry (Sagala et al., 2019). The four aspects namely science, technology, engineering, and mathematics are a harmonious match between problems that occur in the real world with problem-based learning (Force, 2014). So the existence of STEM model is a liaison between the school and the real world experienced by students. Because the real demands of the future are the digital world, robots, and the like related to advanced technology. The STEM learning model trains students in applying the knowledge gained as a form of problem solving related to the surrounding environment and demands for the use of technological advances (Lee, 2021). In STEM learning, knowledge and skills can be used simultaneously by students, different aspects of STEM will require a linkage that makes all aspects can be used simultaneously in learning (Pfeiffer et al., 2013). Therefore, students need to understand all these aspects with the regulation within themselves, in this case, namely Self-Regulated Learning (SRL).

During the learning process, self-regulated learning approach has a role that is an active and constructive process, which students set their own purpose, monitor and regulate their cognition, motivation, and behavior (Boekaerts et al., 2000). So the role of SRL is considered important in the STEM model because all aspects of STEM that students must be able to integrate at once and require self-regulation learning (SRL). This is supported by Baumeister and Vohs (2007) that self-regulation greatly increases adaptability and the flexibility of human behavior, enabling individuals to adapt their actions to a very wide range of social, circumstances, and situational demands. The important role of SRL in STEM is SRL can be control students when students misinterpreted or without good self-regulation it will not good. The principle of learning with the self-regulation learning model is to teach students to be more confident, independent, responsible, and motivated to achieve the learning goals they have set (Panadero, 2017). Self- regulated learning process and environment, students can take responsibility for their own situation learning process by selecting and setting goals, as well as used individual strategies to organize, monitor, and control various aspects that affect of learning-process and evaluate it (Shen et al., 2011). While the opinion of SRL is an independent learning effort where students change their mental abilities into influential skills as their own knowledge, where they will apply learning with learning motivation so that they can appreciate learning, and also by applying self-determined learning so that they do not controlled or dependent on others (Cassidy, 2011).

The integration of STEM in a new Indonesia curriculum today has a lot of aspects allowed it to be included. This statement is supported by Syukri et al. (2013) that the integration of STEM education can not only be carried out between its component fields but can also be integrated between one STEM component field with other fields of science. STEM application has difference between of three STEM approaches lies in the level of STEM content used in learning process (Nong et al., 2022). Those approaches include are silo, embedded, and integrated STEM approach (Anggraini & Huzaifah, 2017).

This research was used an integrated approach in learning that will remove the stigma of fragmented STEM learning. This integrated approach will be able to increase students' motivation and interest in the STEM field.

integrated STEM approach, subjects are integrated with each other namely science, technology, engineering, and mathematics. Integration of all subjects of STEM requires students to connect it all. The integration is begun with the identification of real problems that occurs in the environment and circle of students with using high-level thinking and problem solving skills. Finally students can be drawn conclusion about effort to solve the problems (Wang et al., 2011). In the integrated science, technology, engineering, and mathematics approach, students must be always to active in the classroom, minds on activities and both hands on activities. Therefore, the use of technology and information are needed when applicate in learning process especially physical education to help us find latest science

Self-directed learning and learning based on the new issues are required in implementing STEM learning process. In this case, students and teachers must control or regulate themselves to carry out this STEM model of learning. The existence of SRL is the answer to the STEM challenge, because this SRL improve the adaptability students and flexibility of student behavior, and allowing students to adapt actions to various circle, social, and situational demands. Self-regulation has a place that is important basis for popular conceptions of desired social behavior. The principle of self-regulation learning model is to teach students to be more confident, independent, responsible, and motivated to achieve the learning goals that have been set here (Baumeister & Vohs, 2007). So the role of SRL is considered important in the STEM model because students should be able to integrate aspects science, technology, engineering, and mathematics at once and require self-regulation and control (SRL).

Self-directed learning arises from within students, for this reason, self-regulation is needed to control this. A teenager gets independence or himself becomes independent if he tries to form himself to be independent from others (outside himself). Adolescents who try to find themselves by recognizing themselves, not depending on others, will certainly become independent or form what is called self-reliance (Rini, 2012). In this case, STEM-based SRL learning, which is associated with technology, students must be wise and able to control or regulate themselves to stay on the right track, not to be carried away by bad technology.

Although the STEM-based Self-Regulated learning model has been known to have positive benefits based on previous studies (Baumeister & Vohs, 2007; Nong et al., 2022), however there is still limited research on this model being integrated into physical education classes into a urgency and gap in this study and we are trying to present a novelty in terms of mixing Self-Regulated teaching with the STEM model as an effort to develop self-directed among students. The purpose of this study was to determine the effect of application Science, Technology, Engineering, and Mathematics based Self-Regulated Learning to develop self-directed learning.

METHOD

In this research, the method used quasi-experimental with a nonequivalent-control group design. The data analysis process in this study used the SPSS version 25 computer assistance. This study has a control group sample and experiment group sample.

Population and Sample

Population and sample in this study 54 students of Laboratorium School of Indonesian education university grade VIII, with sampling technique used purposive sampling with criteria: (1) student of Lab. School Indonesian education university grade VIII; (2) has the tools for access to internet; (3) attendance of at least 80% at study; and (4) follow and do all research series.

Instrument

The instruments of this study used the Self-Rating Scale of Self Directed Learning (SRSSDL) by Williamson (2007) to measure directed-learning. This instrument has gone the expert judgment. This instrument consists five aspects indicator, are: (1) awareness; (2) learning strategy; (3) learning activities; (4) evaluations; and (5) interpersonal skills. The research was conducted online learning and limited face-to-face meeting.

Analisis Statistic

All data in this study will be analyzed using IBM SPSS 25.0. The first step is to test the difference in the value of Self-Directed Learning between the experimental and control groups. The level of significance used is 0.05.

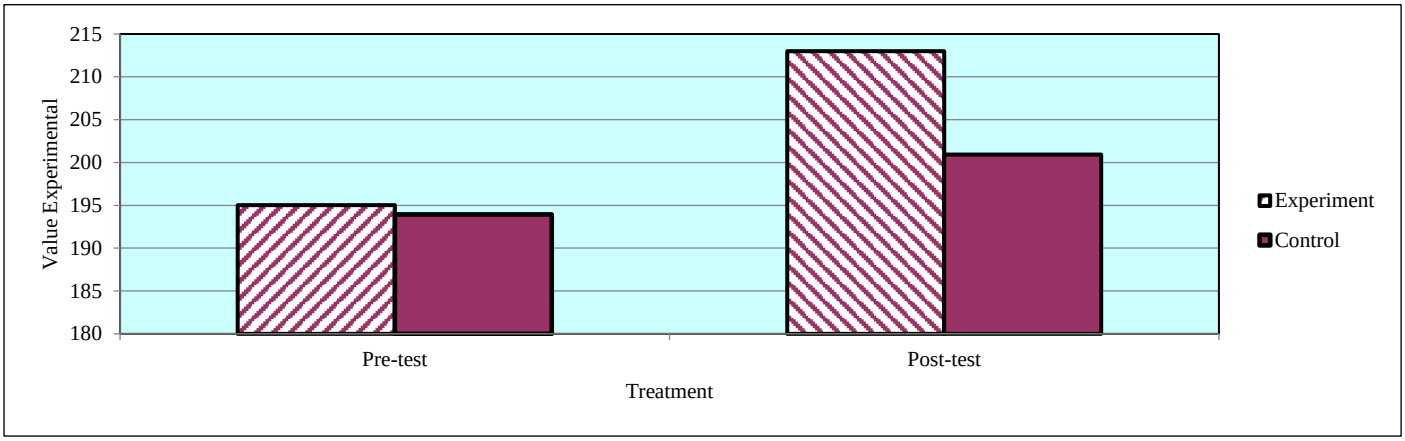
RESULTS AND DISCUSSION

Data of pre-test and pot-test were obtained from the experimental group apply STEM model based on SRL and the control group without application of STEM. The data analysis process in this study used the SPSS version 25 computer assistance.

Table 1. Result of Independent Sample Test (Self-Directed Learning)

No.	Sample Group	Sig.	(α)	Result
1	Experiment	0.027	0.05	Significant
2	Control			

From the Table above, the sig. value is obtained self-directed learning of 0.0027 < 0.005, it can be concluded that there is a significant difference in the effect of application STEM model based SRL and without application of STEM based SRL on development of aspects of self-directed learning.



Graph 1. The Average of Pre-Test and Post-Test (Self-Directed Learning)

From the table above, the results of average and value of the experimental class increased from 195.04 to 213 by 17.96. It can be concluded that the level of self-directed learning the experimental group after being treated with the STEM-based SRL learning model has increased. It is mean that the development of directed learning with STEM-based SRL learning model treatment is better than without STEM-based SRL learning model treatment.

Apart from the results of the questionnaire, this is supported by empirical evidence, namely from the behavior of students when learning and doing assignments. Researchers found the appropriateness of Pannen's theory in Nurhayati (2017) that students who study independently show the development of students' abilities in the learning process does not depend on teachers, friends, class conditions and others. This is shown during the learning process and assignments to students.

This STEM-based SRL has an important role because in STEM-based SRL students easily find information related to learning that will be and is being discussed or the tasks given by the teacher (Li, 2020). The next theory suitability is that students who have higher learning independence are able to manage time and control themselves in thinking, planning strategies, then implementing them, and evaluating or reflecting (Nurhayati, 2017). This is shown by students in the learning and assignment process. Students who have independence are more diligent and the content in their assignments can be said to be better than those who lack learning independence (Çakır & Altun Yalçın, 2022). The initiative in carrying out the task early and the content of the task created indicate the involvement of science and technology in information search and management of

required information. Therefore, getting a completed project in the form of learning modifications is one of the solutions to problems experienced by students during the pandemic. The level of student learning independence can be determined based on how much initiative and responsibility students have to play an active role in learning planning, learning processes, and learning evaluations (Fahradina et al., 2014).

The followings are some statements from previous research and show how physical education and health play an important role in preparing students for a future in STEM (Erwin, 2017). The STEM approach has met the criteria to be given to students in learning and can be used in improving students' science process skills (Syukri et al., 2021). STEM can develop students' skills in everyday life in the 21st century which is constantly changing (Putri et al., 2021).

Learning with the STEM model facilitates students to use multi-disciplinary in solving problems in current Physical Education learning as well as introducing engineering and technology processes. Schools need to provide recommendations to teachers to gain knowledge, to implement, and to develop STEM-based learning. Therefore, in this case students and physical education teachers must be able to regulate themselves in facing the challenges that exist in the STEM model (Lee, 2021).

The STEM learning model will certainly be very necessary for education today, by utilizing increasingly advanced technology, STEM will be very suitable to be applied in learning, especially physical education. Currently, learning can take place virtually, in the form of connectivity between students and teachers, technology, data, and science have spread everywhere, known as the Internet of things (IoT). As a consequence of this, teachers and students as the next generation must be equipped with skills and self-regulation to survive in this modern era both in digital literacy, critical thinking, communication, and creativity in solving problems.

These skills can be developed through STEM learning based on SRL, especially in the field of Physical education. Zimmerman (2013) regarding the self regulated learning strategy can be translated as follows: self evaluation, organization and transformation, goal setting and planning, information seeking, record learning, self monitoring, environmental structuring, giving self consequences, rehearsing and memorizing, seeking social assistance, review notes books, or test. One example of STEM activities on Sports Day involves virtual reality where students place themselves inside a professional soccer stadium and are guided in a conversation about technique and technology (Wajciechowski & Hemphill, 2019).

One example of STEM activities on Sports Day involves virtual reality where students place themselves inside a professional soccer stadium and is guided in a conversation about technique and technology (Wajciechowski & Hemphill, 2019).

This is an explanation of each aspects STEM based SRL in PE:

1) Science, it has the role preparing students to think and action as a real scientist, makes and submits the questions until makes hypothesize and does investigations using practices that are following scientific rules (Anggraini & Huzaifah, 2017). This part provides students in physical education learning process to develop their abilities and be able to participate in making own decisions used scientific knowledge. In this aspect of the SRL phase, namely thinking and finding understanding, setting goals (feeling involved in setting learning goals, managing tasks, and adjusting the level of difficulty have a role in the learning process.
2) Technology, this part directly related with human needs like economic situation, cultural local, social environment, or environmental aspects obtained from the problem solving process and develop the new products (Barak, 2015). This part has big opportunities for students to know and to face technology as a positive change. Part of SRL approach here is manage tasks and adjust or adaptation the difficultis with the presence of technology. Hereby learning process can be achieved with easier. One of them is a virtual meeting during a pandemic. This is one example of learning activities that continue to take place in physical education because of the assistance of technology. At this stage self-control in adjusting to new and independent circumstances in the learning process must exist in students.
3) Engineering, the role of technique in STEM learning process is an important part of bringing all aspecs STEM to PE subjects. This section provides students with a systematics with approach to solve the problems that occure naturally in four aspects of STEM (Kelley & Knowles, 2016). The role of SRL in this section is to provide opportunities for technology that can be developed through project-based learning

by incorporating it into Physical Education subjects in particular. Activities that can be carried out in the learning process are making modifications of learning tools and using them in the learning process. This makes it easier if there are no adequate facilities and infrastructure in schools.

4) Math, Williams (2011) argues that contextual of learning should give a meaning to mathematics. This has a reason that students are curious why they need to learn about mathematics subject. In their minds they always think about how mathematics has an important role in their life and has high relevance. This section shows how self-evaluation is carried out by students (it is part of self-regulated learning) they try to link ideas and ideas in solving problems, especially in learning physical education in the schools.

The STEM-based SRL model is a model that connects and integrates Physical Education in schools relevant to the needs of life in the present and future. This model seeks to illustrate and make students as well as train students to apply the knowledge learned in the school with the phenomena that exist in the surrounding environment. The STEM-based SLR model is a model that implements knowledge to make self-motivation and is expected to become a behavior in terms of managing technology to help solve problems especially in physical education (Hasim et al., 2022).

CONCLUSION

Science, Technology, Engineering, and Mathematics (STEM) based on Self-Regulated Learning (SRL) is an alternative learning model in Physical Education. Regardless of the results, this is supported by empirical evidence from student behavior, learning, and task making. They showed the development of students' abilities in the learning process did not depend on teachers, friends, class conditions, and others. It can be concluded that implementation of Science, Technology, Engineering, and Mathematics (STEM) based on Self-Regulated Learning (SRL) has an effect on develop self-directed learning. This research contributes to learning innovation in physical education, so that teachers can apply this model on an ongoing basis to develop self-directed students. Future research needs to be done, for example trying to apply this model to develop other potentials in students such as motivation, cooperation, or responsibility.

ACKNOWLEDGEMENTS

Thank you to all those who have been involved in this research.

CONFLICT OF INTEREST

There is no conflict of interest whatsoever in this research.

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