Service-Learning in Biochemstry Course: A Model to Improve the Problem-Solving Skills of Biology Education Students

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Abstract: Collaboration, communication, and problem-solving skills are becoming increasingly important in the modern workplace. Integration of learning activities, research, and community service was discovered to be an effective way to develop these abilities in students. The present study employed a mixed-methods sequential explanatory design to examine the effect of the service-learning model on seventeen college students. Observation, interview, and a problem-solving test were used to collect the data. The data were analyzed qualitatively and quantitatively. The quantitative data analysis was performed using the parametric pretest and post-test design. The results showed that participants' problem-solving skills improved after being exposed to the service-learning model, indicated by the significance value of more than 0.05 in the non-parametric Wilcoxon test. Likewise, the qualitative analysis indicated that 95% of the participants considered the SL model effective in improving their problem-solving skills, especially the abilities to explore content, identify problems, solve the problems, and communicate scientific concepts.

Keywords: Biochemistry; Problem-solving skills; Service learning

Introduction

The Indonesian government is currently implementing "the independent campus" policy to prepare the next generation for the future world of work and various social, cultural, and technological problems and transformations of the 21st century. This policy mandates higher education stakeholders to establish a curriculum based on outcome-based education (OBE) and to plan and implement active, innovative, and meaningful learning processes. To realize this objective, learning should encompass not only cognitive, affective, and psychomotor domains of learning, but also metacognitive, collaborative, and problem-solving. Through the implementation of "*tridharma*" (the threefold mission of higher education), which incorporates education, teaching, research, and community service, learning occurs both inside and outside the classroom. The incorporation of "*tridharma*" into the classroom can enhance the quality of learning if it is conducted according to proper research principles and processes (Mahzumi, 2016). Many studies and training relevant to *tridharma* have been conducted (Arif et al., 2022; Haerani et al., 2022).

In a while, the tridharma activities continue to be carried out individually, with lectures, power point presentations, and classroom discussions dominating learning activities. The majority of learning activities in tertiary institutions take place in class, with the understanding that every week, face-to-face assignments (50 minutes/college credit) must be completed by the students. Syllabi and semester-long learning plans, two forms of educational resources, are currently being developed without yet referencing learning outcomes. Instead of focusing on unlocking students' true potential (authentic assessment), the evaluation process typically focuses on assigning students scores/grades. Students' ability to criticize

material/information presented by friends or lecturers has not developed well (Saputri et al., 2020).

Thus, this educational system must be transformed from lecturer-centered learning to student-centered learning. Student-centered learning should be founded on three principles: 1) knowledge is something incomplete; 2) learning is a process of reconstructing and locating knowledge; 3) the learning process does not merely include standard teaching method or execute conventional instructions.

The current study examined efforts to create a novel, engaging, and effective learning environment. It also stressed the implementation of a learning paradigm that could facilitate the growth of students' creativity, skills, personalities, and needs, as well as their independence in seeking and gaining knowledge and serving the community. This learning paradigm is more commonly referred to as service learning. In this study, the service learning model combined academic learning activities with community service.

The key feature of service learning is reflective learning activities in which students establish connections between concepts studied, real-life experiences, and knowledge of science (Cronley et al., 2015; Dewey, 1938; Dezure et al., 2002; Kuh, 2008). Student participation in service learning, on the other hand, affords them the opportunity to gain scientific knowledge, stimulate their future careers, and benefit the nation and state.

Service Learning provides benefits to students by increasing aspects of thinking, engagement in learning, and cognitively diverse problem solving approaches (Benning et al., 2022). Service learning is emerging as a central component of efforts to link disciplinary learning and general education with a historic and increasingly prominent commitment to public causes (Felten et al., 2011). In carrying out service learning, students apply the theories and concepts learned in class into practice, then reflect on the service and make a report on the implementation of activities (Yusuf et al., 2020). Service Learning can be an effective means of developing, maintaining, or improving relationships between higher education institutions and local communities (Roman, 2015). Service learning supports the development of academic, professional and other competencies to succeed in a competitive and ever-changing world (Hooli et al., 2023).

Service learning is a learning model that connects positive and meaningful action in society with academic learning, personal development and responsibility as a citizen. Service learning was chosen because it contains elements of service activities which are a passion for developing society (Antasari et al., 2019). Service-learning (SL) is a form of project-based learning that

meets academic learning goals by preparing students to use their knowledge and skills to work with others to address pressing social problems in their communities (Rimm-Kaufman et al., 2021). Effective service-learning can give students the opportunity to see the positive consequences of their actions (supporting competencies), by practicing alternative solutions by engaging in collaboration. These psychological experiences lead students to active learning, develop confidence in their own abilities, and increase interest in learning (Deci et al., 1991). Service-learning improves educational implementation by deepening the curriculum and encouraging students to put learning material into context (Meyers, 2009).

Service learning can improve student academic outcomes (Warren, 2012), and the learning environment by providing students with experiences to develop skills and competencies such as communication and listening skills, leadership skills, and social responsibility (Salam et al., 2019; Steinberg et al., 1999). Service learning is an experiential teaching method that combines teaching with community service to enrich students' academic learning, interpersonal skills, and sense of responsibility while making meaningful contributions to society (Bassi, 2011). The accumulation of bilateral relations between students and the community has succeeded in strengthening mutual benefits (Omar et al., 2022). Service learning enriches the entire student learning experience by considering learning objectives and service outcomes that are mutually beneficial between students and society (Bodorkós et al., 2009; Sutheimer et al., 2011).

Research has documented the advantages of service learning. Mayer et al. (2016) suggested that service-learning can enhance students' learning processes and empirical experiences. Olberding et al. (2016) discovered a mutually beneficial interaction between the college and the community represented by the service center. Many studies have demonstrated that service learning can improve student social responsibility and leadership (Rutti et al., 2016; Weiler et al., 2013). Empowering metacognitive skills has an important role in increasing students' thinking capacity and cognitive processes in learning (Amin et al., 2020).

The most recent study by Tomat (2020) demonstrates that student participation in service-learning projects can improve their science communication abilities and have a positive impact on recipients (community). This research concurs with the findings of Harrison et al. (2013), who discovered that incorporating service learning into learning activities can increase students' communication, writing, and critical thinking skills. Creating fun learning activities that allow students to experience examples of concepts

related to the environment around students is worth doing to attract students' interest in learning (Kurnianto et al., 2024). The use of appropriate learning strategies can influence student activity in the learning process (Amin et al., 2018).

These research findings indicate that educators and researchers are becoming increasingly interested in the application of service learning as an educational approach. Among these studies, however, very few research and scientific papers indicate the impact of the service-learning model on students' everyday problem-solving skills. Thus, the present study employed the service-learning model to a biochemistry course to enhance biology students' problem-solving skills. This study was inspired by the fact that biochemistry is difficult for students to comprehend and that the implementation of conventional learning in the classroom should be minimized.

Understanding biochemistry demands an in-depth comprehension achieved by discovery, mastery, comprehension, and dissemination activities. In biochemistry classes, students must be taught how to obtain content, comprehend content through discussion, connect content to real-world examples, and communicate it to others. Students can be taught biochemistry basics using service-learning. Allowing students to study biochemical information independently through modules, books, and videos prior to classroom activities is the initial step in service biochemistry learning. The next step is to allow students explore the topic in small groups. In groups, students need to make connections between biochemical concepts and everyday issues, followed by designing a program to handle biochemical problems encountered in daily life. In this classroom, students and the professor should agree on assisted communities and plan assisted activities, which can sharpen students' problem-solving skills and help the community.

Method

The current study employed the explanatory sequential mixed methods design. The quantitative data were obtained through a quasi experiment with pretest and post-test. The qualitative data were collected in the form of student perceptions of the effect of service learning on their problem-solving skills.

The research population comprised twenty sixth semester students from the biology department who were enrolled in a biochemistry course. Because their number was so small, the sample in this study was drawn from the entire population. Three participants were excluded from the sample, however, because they did not attend the eight sessions scheduled throughout the experimental study. As a result, the remaining 17 students served as research subjects in this study.

The research instruments included a test to assess participants' problem-solving skills and an open-ended interview guideline to elicit participants' perceptions of the service-learning effectiveness in enhancing their problem-solving skills. The problem-solving test consisted of six essay questions on Bloom's Taxonomy cognitive levels 4-6.

The first stage in this research was to provide pupils with basic concepts of biochemistry. Following this exercise, service learning was incorporated into the biochemistry course. Together with the participants, we identified community partners for the service project. Participants could take part in both an external service and an external learning activity. We separated service learning into three sections. First, face-to-face learning activities in class were combined with non-face-to-face learning activities by task assignments.

In the classroom, participants learned by relating biochemistry concepts to their community service projects. During four face-to-face meetings, participants engaged in biochemistry-related assignments, presentations, design of school-based service materials and activities. In class, students also examined the learning material, drew connections between the material and real-world issues, and identified solutions to these issues.

Table 1. Implementation of Service Learning

Learning	Students learn material at home/class through models, books, or other references obtained from the internet
Classroom	Mahasiswa mendiskusikan materi secara berkelompok, mengidentifikasi permasalahan dalam kehidupan sehari-hari yang berkaitan dengan materi biokomia, merancang kegiatan layanan.
Community	Mahasiswa bersama komunitas melakukan riset sederhana untuk mengidentifikasi permasalahan pola komsumsi makanan, dampak, dan akibat yang dirasakan oleh masyarakat.
Service	Mahasiswa melakukan kegiatan layanan di masyarakat terkait dengan sosialisasi pola komsumsi makanan yang mengandung karbohidrat, protein, lemak, vitamin, dan mineral.

In the learning phase, students attended lectures and completed assignments. To prepare for inside- and outside-classroom learning activities, the lecturer designed supplementary activities. The learning activities were designed to align with the service-learning learning objectives. The instructor and students established a meaningful connection between lecture activities and the service-learning program. In addition, they created links between the bichemistry classes and service programs in schools.At the presentation and discussion stage, participants prepared a paper to be presented in front of the class. After obtaining feedback from peers and the lecturer, the paper was followed up with research to determine, for instance, the food consumption patterns of students in a school. The findings of the investigation were presented to the class. Students then formulated community service projects. At the presentation stage, students could display posters and pamphlets to solicit feedback from their peers in other groups.

During the service phase, students and the lecturer in the biochemistry classroom visited a school and informed the students about food consumption patterns. A community service project, in this case, is a means to comprehend biochemistry, communicate the material studied, apply biochemistry in everyday life in relation to food consumption patterns, and investigate the impact of biochemistry on human health. At this stage, participants learned to convey to the public the significance of sustaining a healthy diet.

Students created posters, pamphlets, and powerpoint and papresentations to campaign food consumption patterns and their effects on health. After completing service activities, students completed their final assignment, a report on the outcomes of the socialization of food consumption patterns at school. Then, a problem-solving test was administered to the participants. Then, they were asked to express their opinions regarding the service-learning activities.

Data analysis consisted of quantitative data analysis employing inferential statistics and qualitative data analysis by describing the outcomes of participant interviews. Data were collected, organized, and processed methodically through clear descriptions, with no intention of generalization. The research hypothesis was tested using inferential analysis. The t-test was utilized for statistical analysis in this investigation.

Before hypothesis testing, assumption tests were conducted. The normality of data distribution was examined using the Kolmogorov-Smirnov Lilliefors Significance Correction test at 5% level of significance or α = 0.05. Data were normal when the significance level was bigger than 5% (α = 0.05). If the data were not distributed normally, a difference test was conducted using the Wilcoxon Signed Ranks Test. We utilized the Windows SPSS program version 20 to perform all the tests.

Results and Discussion

The Effect of Service Learning on Students' Problem-Solving Skills

The descriptive statistical test showed that seventeen students engaged in service learning experienced an increase in problem-solving score. Tabel 1 summarizes the results of the test.

Table 2. Results of the Descriptive Statistical Test on Students' Problem-Solving Skills in Service Learning

	N	Minimum	Maximum	Mean	Std. Deviation
Pre-Test	17	31.25	66.67	46.6906	10.23462
Post-Test	17	66.67	91.67	74.7547	8.95738
Valid N (listwise)	17				

Based on Table 2, participants obtained the lowest score of 31.25 and the highest score of 66.67 on the pretest. On the post-test, participants achieved the lowest score of 66.67 and the highest score of 91.67. There was a 25.00 increase in the participants' score from the pretest to the post-test. We conducted a normality test before running the inferential statistical test. Table 3 records the normality test results.

Table 3. Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	df	Sig.
pretest score	.159	17	.200*	.954	17	.523
post-test score	.316	17	.000	.763	17	.001

The Saphiro-Wilk normality test was used because the research sample number was less than 50. The results showed that sig 0.523 > 0.05 for pretest, indicating that the data were distributed normally. However, sig 0.001 < 0.05 for post-test, indicating that the data were not distributed normally. Therefore, parametric analysis could not be conducted. In other words, the data were examined using the Wilcoxon non-parametric test. Table 4 presents the results of the Wilcoxon test.

Table 4. The Results of the Wilcoxon Signed Ranks Test

		N	Mean Rank	Sum of Ranks
Posttest score – Pretest score	Negative Ranks	0[a]	.00	.00
	Positive Ranks	17[b]	9.00	153.00
	Ties	0[c]		
	Total	17		

Table 5. Test Statistics

	Posttest score-pretest score
Z	-3.624[a]
Asymp. Sig. (2-tailed)	.000

The Wilcoxon test results showed that Asymp. Sig. (2-tailed) 0.000 < 0.05; hence Ho was rejected, and Ha was accepted. This suggests that there was a significant difference between the pretest score and the post-test score. In other words, there was an increase in participants' score, from the pretest to the post-test.

Students' Perceptions of the Service-Learning Implementation

Reflection on the implementation of service-learning incorporates participants' perceptions of the learning model's implementation. In interviews, three out of seventeen participants acknowledged to feeling confused about the service-learning assignment due to their lack of prior exposure to such learning. The following excerpt supports the finding.

> At the beginning of the biochemistry class, I felt like I had a lot to do because I had to make papers for presentations and power point slides, among other things. This confused me. But I got used to it after that.

The student's response was distinct from the responses of the other 14 students, all of whom had stated that they had been challenged by the assignments that had been provided in the service-learning classroom. The fourteen students admitted that the assignments were helpful in improving their understanding of the challenging biochemistry material that was full of chemical formulas and terminology. The accompanying interview excerpt provides further support for this finding.

> We have a very challenging time with biochemistry. When you presented the information at the very first meeting, I already had the impression that it was going to be difficult. However, to study and comprehend the material, as well as to be able to discuss its meaning with my peers, I must read the book and complete the assigned tasks. Alhamdulillah (I thank God) that as time went on, I started to comprehend it (biochemistry), and I came to the conclusion that biochemistry was actually quite relevant to our day-to-day existence.

When participants were provided the opportunity to learn both inside and outside of the classroom, it seemed to pique their curiosity and make them happy. The findings of the interviews indicated that the participants had a positive experience interacting with their peers and with high school students when participating in the learning activities and service activities respectively. Their happiness was evident when they departed and encountered the students and their teachers from the selected high school. Participants were given the opportunity to develop original solutions to challenges faced by students at school tha were associated with their patterns of food consumption through service-learning activities. The findings are supported by the following interview excerpt.

> I'm very happy and interested in how I can learn and teach high school students. It seemed like something new, and it was the first thing I felt. But I learned a lot from talking with my friends in class, practising how to teach students, and working with students directly in high school.

Participants also showed motivation and admitted being able to empathize with those who are affected by the biochemical issues in daily living. According to them, biochemistry is not difficult to master if it is relevant to daily life. They too would benefit from being aware of healthy eating habits. They reported having acquired a great deal of knowledge by studying biochemistry, not only about the concept of biochemistry but also about its role in daily life. The findings of the interviews, which will be presented below, support this finding.

> After completing the biochemistry course, I came away extremely impressed. Not only did I gain an understanding of the concepts, but I also earned experience working with secondary school pupils. I was required to understand biochemical concepts that are associated with eating habits in everyday life, such as diseases that are caused by an excess or deficiency of biochemical substances such as carbohydrates, vitamins, and others. Having this knowledge allowed me to adequately describe it to the students at the high school.

Discussion

Students can improve themselves not only on an individual level but also on a societal and academic level through participation in service learning. College students gain a better understanding of their place in society when they participate in service learning (Dukhan et al., 2009). Service-learning can enhance college students' problem-solving skills. The goals of this study can be understood by looking at the findings of both quantitative and qualitative research (i.e., the perspectives of students). According to the findings of this research, the most effective way for college students to hone their ability to find solutions to problems is for them to participate in service learning.

After participating in service learning, participants' test data were analysed using descriptive statistics, which revealed that there was an improvement in the participants' problem-solving skills. Their problem-solving scores increased significantly from 46.69 (pretest) to 74.75 (post-test). The findings of the Wilcoxon test indicated that the Asymp. Sig. $0.000 < 0.05$; consequently, the null hypothesis was dismissed in favour of the alternative hypothesis, which is Ha. These statistics demonstrate that there was a substantial difference between the scores on the pretest and the scores on the posttest, as well as that there was an increase in scores from the pretest to the posttest.

The findings of this research agree with the findings of other studies that have been conducted in the past. According to Anderson et al. (2019), effective service learning not only improves college students' learning outcomes, but it also improves their understanding and high-level skills, such as collaboration, communication, and connections. The rise in participants' test scores can be attributed to the participants' high levels of motivation to complete the service-learning activities. The Biochemistry course involved numerous activities. In class, the participants were taught about the fundamentals of biochemistry as well as their relevance to contemporary issues facing society. Thus, they could experience self-development and use higher order thinking skills to solve everyday problems.

According to Armstrong et al. (2021), service learning that focuses on solving fundamental science problems can motivate students to learn, generate work, and engage in service activities. This is consistent with the findings of Castellanos et al. (2021), who demonstrated that implementing the service-learning model to chemistry education students assisted them in teaching chemistry concepts in an easier manner to elementary and junior high school students. Thus, these elementary and junior high school pupils developed a favourable view of science. Current research findings indicate that students who participate in service learning are highly motivated to learn, which impacts their academic performance.

Sewry et al. (2018) discovered that biochemistry courses utilizing the service-learning model can promote social awareness, civic responsibility, self-confidence, comprehension, communication skills, science demonstration, and personality development. Similarly, Harrison et al. (2013), demonstrated that the service-learning model can motivate students to learn and perform service, thereby enhancing their communication, writing, and critical thinking skills.

Conclusion

The present study demonstrates that biochemistry can be taught by combining classroom activities with community service. This model of instruction is known as the service-learning model. The findings of implementing service learning in this study indicate that students are actively involved in lectures by integrating the knowledge obtained in the classroom, outside of the classroom, and in real life in society. This ultimately impacts students' abilities to solve problems. These results align with how students perceive service learning. The majority of students concurred that service-learning activities were extremely difficult, particularly when studying biochemistry. Students who initially struggled to adapt to service-learning assignments eventually comprehended the material and realized the relevance of biochemistry to their daily lives.

Authors Contribution
The author is involved in the overall making of this article.

Confict of Interest
The author declares no conflict of interest.

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