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Developing a Project-Based Learning Model with Peer Guidance to Improve Student Self-Efficacy in Higher Education

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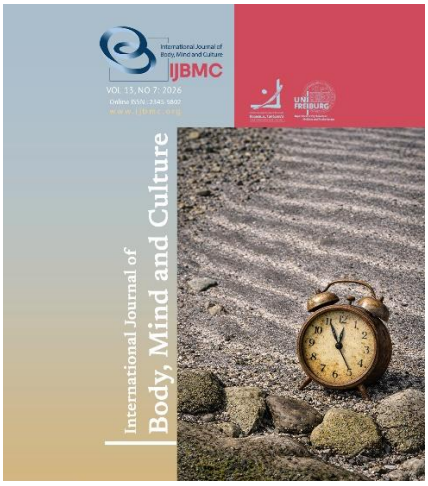

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ABSTRACT

Objective: Self-efficacy is an important characteristic that affects students' learning participation and academic achievement in higher education. The purpose of this study was to establish a Project-Based Learning (PjBL) model based on peer tutoring and to investigate initial changes in students' self-efficacy after the deployment of this model. Conceptually, the study was concerned with the dimensions of level, strength, and generality.

Methods and Materials: The research method used is Research and Development (R&D) with the Dick and Carey development model. A quasi-experimental one-group pretest–posttest design was used for preliminary testing. The participants were 32 students of the Geography Education Study Program who took the Basic Geographic Information Systems (GIS) course. The data were acquired using a self-efficacy questionnaire, expert validation sheets, and classroom observation sheets. Data analysis included descriptive statistics, N-Gain analysis and paired sample t-tests.

Findings: Results indicated that the mean score of self-efficacy increased from 46.40 in pretest to 55.62 in posttest. Pretest and posttest scores were significantly different (paired sample t-test, $p < 0.001$). The mean N-Gain value was 0.54, which was classified as moderate improvement. Also, the posttest results showed less variance, which means a more homogenous distribution of students' self-efficacy following the intervention.

Conclusion: The results show preliminary evidence that the peer-tutoring-based PjBL model was related to an increase in students' self-efficacy after its deployment in the GIS learning context.

Keywords: Self-Efficacy, Project-Based Learning, Peer Tutoring, Higher Education, GIS Learning.

Introduction

Project-Based Learning (PjBL) is becoming popular in universities for improving several skills in students, such as critical thinking, teamwork, scientific literacy, and other important skills needed in the 21st century (Cahyani et al., 2025). However, the success of PjBL implementation often depends on students' ability to control their learning, actively participate in group work, and maintain their confidence in the face of difficult academic tasks (Rohmaniyah & Asih, 2024). In this sense, self-efficacy is an important variable since it influences the students' motivation, tenacity, and overall academic achievement (Shengyao et al., 2024). Albert Bandura defined self-efficacy as the belief that an individual has in their capacity to plan and perform the actions required to accomplish specific goals. He also distinguishes three elements of self-efficacy; level, strength and generality. Level refers to the level of difficulty that students feel they can successfully perform a task, strength refers to the extent of confidence that they strongly feel in their capabilities, and generality refers to the extent to which their beliefs in their abilities may be generalised to different activities or contexts.

Research has shown that peer tutoring and collaborative learning are beneficial for students' self-efficacy, academic achievement, and participation in higher education settings (Ngoc Tuong Nguyen & Thi Kim Oanh, 2025). Peer tutoring allows kids to learn through observing their peers, sharing ideas, getting feedback, and gaining social support from classmates with similar academic backgrounds (Sadykova, 2014). Moreover, PjBL encourages students' collaborative and independent efforts to solve real-world problems and encourages ownership of the learning process and active engagement (Al-Qoyyim & Kurniawan, 2025). Several studies have also found increased students' confidence and motivation through learning via observation, verbal reinforcment and/or experiences of mastery in peer-assisted learning contexts. However, the existing literature tends to focus on the outcomes of general self-efficacy and does not explore the development of the level, strength, and generality components in the context of PjBL with peer tutoring.

Moreover, much of the previous work on self-efficacy was conducted in situations only tangentially related to peer tutoring-based PjBL in higher education, such as online maths education, AI-supported language teaching, inclusive elementary school education, hackathons or bibliometric research. These studies are informative on collaborative learning and student confidence, but they do not immediately shed light on the effect of the combination of peer tutoring and PjBL on the nuanced makeup of student self-efficacy in university settings. It is therefore necessary to investigate more accurately how peer tutoring in PjBL leads to improvements in each aspect of self-efficacy in learning contexts at the university level (Sutopo et al., 2024).

The theoretical premise of this study is Bandura's self-efficacy theory and in particular the four key sources of self-efficacy: mastery through experience, vicarious learning, verbal encouragement and physiological or emotional states. In PjBL with peer tutoring, students get mastery experiences from successful project completion, vicarious experiences by observing peer tutors, verbal motivation from peers and instructors, and emotional exchanges that support each other in collaborative educational activities (Minangsari et al., 2025). These methods are designed to increase students' confidence in their capacity to manage academic assignments of varied levels of difficulty, to maintain their confidence over time, and to transfer their skills to different learning contexts.

In this case, the present study is intended to develop and test the Project-Based Learning model with peer tutoring to boost the self-efficacy of university students. The project aims to answer, in particular, the following questions: (1) Is the feasibility of the PjBL model based on peer tutoring confirmed by experts? (2) Is there a successful model in terms of classroom implementation? (3) Does the model application improve the students' self-efficacy? (4) Are there different improvements in level, strength and generality parameters after intervention? This study will contribute to the theory of self-efficacy and collaborative learning and have practical implications for the development of novel educational approaches in higher education.

Methods and Materials

Study Design

This research applied a Research and Development (R&D) process to develop, validate, and evaluate a peer tutoring-based Project-Based Learning (PjBL) model in

order to improve self-efficacy of university students (Hartono et al., 2026). It employed the instructional design framework of Dick and Carey because it provides an organised way to plan, implement and evaluate educational innovations (Sapri et al., 2019). The research also used a quasi-experimental design with one group pretest and posttest design as a preliminary test to find out changes in student self-efficacy before and after the use of the model (Plemmons et al., 2018). However, this setup was restricted to determining initial effectiveness and could not prove causal links due to the lack of a control group.

The stages of development adhered to the Dick and Carey framework and were carried out methodically across various stages (Mashudi, 2025). Initially, a needs assessment was performed by observing classrooms and interviewing teachers and students in the Basic Geographic Information Systems (GIS) course to pinpoint educational issues linked to teamwork, learning independence, and self-belief (Nicholson et al., 2023). The findings showed that students struggled with completing projects on their own and had a lack of confidence in collaborative learning settings.

Next, analyses of learners and context were carried out to understand the academic traits of students, their past learning experiences, and their educational requirements in GIS teaching. Following this, learning objectives were defined to enhance the dimensions of students' self-efficacy, such as level, strength, and generality, using peer tutoring-based project-based learning (PjBL) activities. After that, evaluation tools were created, which included self-efficacy surveys, validation forms from experts, and observation sheets from the classroom.

Then, teaching strategies and educational resources were crafted by incorporating peer tutoring methods into the phases of PjBL, such as project introduction, cooperative planning, executing the project, mentoring peers, presenting, and reflecting. Subsequently, formative assessments were carried out through expert validation and small-scale classroom trials to evaluate the model's effectiveness and practicality (Anders et al., 2022). Recommendations from the validators were utilized to improve instructional methods, educational materials, and peer tutoring processes. In the end, a field trial and conclusive evaluation were performed to analyze the application and initial impact of the model on enhancing students' self-efficacy.

The group of participants was made up of 32 undergraduate students who were part of the Geography Education Study Program and were taking the Basic GIS course when this study occurred. The participants were chosen through purposive sampling as they fulfilled the specific traits needed for the execution of the proposed learning model. The inclusion criteria were: (1) current enrolment in the Basic GIS course, (2) voluntary participation, and (3) attendance at all instructional sessions during the intervention. Those students who did not complete the intervention sessions and did not complete the research instruments were excluded from the final analysis.

The participants were third-semester undergraduate students from a variety of academic disciplines and with varying amounts of previous GIS expertise. All students in the selected class volunteered to participate in the study and all agreed to do so. No participant dropped out during the intervention phase. However, because of the small sample size, and that it was limited to only one study program, the results should be considered cautiously regarding statistical strength and generalisability.

The program was based on a peer tutoring approach within a project-based learning (PjBL) framework carried out over a period of six weeks with meetings held weekly (Suharto et al., 2019). Meetings lasted approximately 100 minutes each. Students collaborated on projects linked to GIS that involved working with geographical data, making digital maps, interpreting themed maps, and solving geographic problems.

Peer tutors were chosen on the basis of previous academic achievement, communication skills, and recommendations from professors. Before the program these tutors had a short instruction on tutoring strategies, supporting collaboration, giving feedback and guiding projects (Burgess & McGregor, 2018). During the implementation, peer tutors enabled the group members to understand the concepts of GIS, to overcome the technical challenges, to create discussions and to encourage active participation.

Students were grouped into small groups of four to five individuals by different grouping methods based on their academic skills. The whole process of learning has been facilitated, overseen and assessed by the professor.

The steps of the project were: Project launch, Planning, Investigation, Product production, Presentation, Peer review, Revision, and Reflection (English & Kitsantas, 2013).

Feedback was constantly offered through discussions amongst peers, help from tutors, consultations with the lecturer and activities that focused on classroom reflection (Hunukumbure et al., 2017). Project evaluation criteria included work completion, quality of collaboration, use of GIS abilities, performance in presentations, and participation in reflective activities (Németh & Long, 2012). The reflection exercises were purposefully designed to promote the three characteristics of self-efficacy (Hsia & Hwang, 2020). The dimension of level was addressed by introducing project assignments of increasing difficulty, the dimension of strength was created through repeated success and constructive feedback, and the dimension of universality was developed through the usage of GIS abilities in other problem situations. Classroom observations were conducted in all sessions using standardised observation forms to ensure that the implementation plan was followed.

Student self-efficacy was measured using a Likert-scale survey designed based on Bandura's theory of self-efficacy. This tool had 24 questions in three categories: level (8 questions), strength (8 questions) and generality (8 questions). Responses were scored on a five-point Likert scale from 1 (strongly disagree) to 5 (strongly agree), with a total score of 24–120.

Some sample questionnaire items were: "I feel that I can handle difficult tasks in GIS projects" (level), "I feel confident even when facing challenges in my project work" (strength), and "I can apply GIS skills learned in class in different situations" (generality). The questionnaire was adapted from previous studies on self-efficacy and modified to fit the context of learning GIS.

The content validity of the instrument was evaluated by three experts in educational technology and geography education. Reliability was measured using Cronbach's alpha coefficient, which showed that there was acceptable internal consistency for the overall scale and each individual category. A pilot test was carried out prior to the main research to confirm the clarity and readability of the items (Fraser et al., 2018). Furthermore, expert evaluation forms and classroom observation checklists were employed to measure the practicality and feasibility of the proposed model. These tools reviewed aspects of instructional design, implementation methods, learning interactions, and peer tutoring activities.

The gathered information was examined through descriptive and inferential statistical methods. Descriptive statistics were utilized to assess the practicality and viability of the created model, relying on expert validation ratings and observations in the classroom (Saputri et al., 2019). Inferential statistics were employed to investigate the variations in students' self-efficacy before and after the intervention took place.

Before testing the hypothesis, the normality of the data was assessed with the Shapiro-Wilk test (Rochon et al., 2012). Since the data conformed to the assumptions of normality, paired sample t-tests were applied to compare the scores from the pretest and posttest. The analysis covered the total self-efficacy scores along with distinct analyses for the aspects of level, strength, and generality. Statistical significance was set at the 0.05 threshold.

The success of the intervention was further measured with the normalized gain (N-Gain) formula:

$$N\text{-}Gain = \frac{Posttest\text{-}Pretest}{Maximum\ Score\text{-}Pretest}$$

The highest achievable score on the questionnaire was 120. Cohen's d was used to compute effect sizes for paired samples in order to assess the extent of changes from pretest to posttest scores. Additionally, confidence intervals for the differences in means were provided. Before starting the analysis, missing data were reviewed, and since every participant finished the study, there was no need for any procedures to handle missing values.

This research obtained ethical permission from the research ethics committee of the institution before gathering data. All participants signed written consent forms before taking part in the study. Students were made aware that their participation was optional and that their choice to join or leave would not impact their academic scores. Privacy and anonymity of participant information were preserved during the entire research process, and all data collected were used only for research aims.

Findings and Results

The results of this study are presented based on the stages of the Research and Development (R&D) process, namely expert validation, practicality test, formative evaluation, and effectiveness test of the peer tutoring-based Project-Based Learning (PjBL) model in improving students' self-efficacy.

The created learning model was validated by three specialists in geography education, instructional design, and educational technology. The validation method examined numerous factors such as learning syntax, instructional objectives, peer tutoring procedures, project activities, learning materials, assessment strategies and feasibility of implementation. The average expert validation score showed that the produced model was categorised as "feasible" with minor adjustments before being implemented in the classroom.

The validators' suggestions were mostly related to the explanation of the peer tutor roles, the enhancement of the reflective activities, and the refinement of the assessment rubrics for the project evaluation. When the adjustments were finished the model was declared adequate for field testing.

The practicality test was carried out in limited classroom application using observation sheets and lecturer assessment. The findings of the observation suggest that the learning syntax can be consistently used in all sessions. Students were actively engaged in group discussions, project completion, peer tutoring activities and reflective learning procedures.

Formative evaluation results also suggested that the peer tutoring mechanism fostered more intensive learning exchanges and enhanced students' participation in GIS project activities. Peer tutors were able to help group members with technical and conceptual challenges. Lecturers were effective as facilitators and supervisors. The created paradigm was in general considered feasible and applicable in the learning context of higher education.

The results of the descriptive statistical analysis showed that students' self-efficacy increased after the deployment of the peer tutoring-based PjBL model. The summary of pretest and posttest scores is shown in Table 1.

Table 1

Descriptive Statistics of Student Self-Efficacy

Statistics	Pretest	Posttest
N	32	32
Mean	46,40	55,62
Median	48,00	56,00
Minimum	32	46
Maximum	58	64
Std. Deviation	6,54	4,21
Variance	42,76	17,72

Table 1 shows the mean self-efficacy score increased from the pretest of 46.40 to posttest of 55.62, which indicates a good change following the intervention. The median score also increased from 48.00 to 56.00, showing that majority of the students felt more confident after the use of the learning paradigm.

The minimum score rose significantly from 32 to 46, suggesting that students with initially poor self-efficacy showed major progress. Further, the standard deviation reduced from 6.54 to 4.21 and the variance reduced from 42.76 in pretest to 17.72 in posttest. This finding suggests that the students' self-efficacy scores grew more homogeneous following the intervention, suggesting a more equal confidence level among participants.

Further study was performed for the three characteristics of self-efficacy: level, strength, and generality. The results showed that all dimensions improved following the adoption of the peer tutoring-based PjBL paradigm.

As students gained confidence in executing GIS exercises of varying difficulty, the level dimension grew. The strength dimension also improved, revealing students' greater and steadier confidence when facing hurdles in completing their projects. In the meantime, the generality factor was improved by students' capacity

to use GIS knowledge and problem-solving skills to broader academic contexts and varied project situations.

The strength dimension showed the biggest rise of the three dimensions, followed by level and generality. The results indicate that the several project experiences, the support from collaborative teams and feedback from peers all positively contributed to enhancing students' confidence in their academic ability.

Before conducting inferential analysis, a normality test was performed on the difference scores between pretest and posttest results using the Shapiro–Wilk test. The results are presented in Table 2.

Table 2

Normality Test Results

Data	Statistic	Sig. (p-value)	Information
Difference Scores (Pretest-Posttest)	0.967	0.412	Normal

The Shapiro–Wilk test showed a significance value of 0.412, which was greater than 0.05. Therefore, the difference scores were normally distributed, indicating that the assumptions for parametric testing using the paired sample t-test were satisfied.

Hypothesis testing was conducted to determine whether there was a significant difference in students' self-efficacy before and after the intervention. The results of the paired sample t-test are presented in Table 3.

Table 3

Paired Sample t-Test Results

Variable	Mean Difference	Std. Error	t	df	Sig. (2-tailed)	95% CI	Effect Size (Cohen's d)
Pretest-Posttest	-9.22	0.80	-11.507	31	0.000	[-10.85,7.59]	2.03

The paired sample t-test demonstrated a statistically significant difference between pretest and posttest scores ($p < 0.001$). The mean difference of -9.22 indicates that students' self-efficacy increased substantially after the implementation of the learning model. Furthermore, the effect size value (Cohen's d = 2.03) indicated a very large practical effect of the intervention on students' self-efficacy.

To determine the magnitude of improvement, normalized gain (N-Gain) analysis was conducted using the following formula:

$$N\text{-}Gain = \frac{Posttest\text{-}Pretest}{Maximum\ Score\text{-}Pretest}$$

The maximum possible questionnaire score was 64. The results of the N-Gain analysis are presented in Table 4.

Table 4

N-Gain Results

Category	N-Gain Value	Interpretation
Average	0.54	Moderate

The average N-Gain score of 0.54 falls within the moderate category, indicating that the peer tutoring–based PjBL model produced a moderate improvement in students' self-efficacy. Therefore, the findings suggest that the intervention was sufficiently effective in improving students' confidence in completing academic tasks, although additional refinement and broader implementation may further enhance its impact.

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The results showed that the created learning model was viable, practical and fairly successful in boosting the students' self-efficacy in general. The results revealed that the peer tutoring-based PjBL model had a positive impact on students' academic confidence and collaborative learning experiences with all dimensions of level, strength, and generality being satisfactorily improved.

Discussion and Conclusion

The results of this research show that the self-efficacy score of students increased after the deployment of the Project-Based Learning (PjBL) model based on peer tutoring (Samsudın et al., 2020). This rise was also indicated in the descriptive and inferential statistical results where the posttest scores were greater than the pretest scores (Hassan et al., 2021). However, these findings should be treated with caution because the study employed a one-group pretest–posttest design without a control group (Spurlock Jr, 2018). Hence, the results indicate an observed improvement in students' self-efficacy after the intervention and not the definite causal evidence that the learning model alone caused the improvement.

The observed rise in self-efficacy may be linked to the students' active participation in project completion activities. By means of project-based learning, students are involved in the planning, discussion, implementation, presentation and reflection processes, which offer repetitive learning experiences and chances for task completion (Handrianto & Rahman, 2018). Previous studies have suggested that authentic project experiences and collaborative learning activities might have a positive impact on students' confidence and academic engagement, especially in higher education learning environments that involve problem-solving and applied tasks (Lakhtakia et al., 2022; Oseguera et al., 2022).

The adoption of peer tutoring was also seen to benefit pupils in the learning process. Peer interaction gave students an opportunity to share ideas, seek help and get immediate feedback while solving GIS-related problems. Many prior research have demonstrated that peer tutoring improves collaborative learning, communication skills, and perceived academic support, which are correlated with increases in learning confidence and involvement (Graham et al., 2019; Seevaratnam et al., 2023). The students' participation and engagement in project activities increased after the intervention was applied in this study.

The study had conceptually discussed the characteristics of self-efficacy such as level, strength and generality, but the present results were focused largely on overall self-efficacy scores. Therefore, interpretations of improvements in individual aspects should be regarded as tentative because of the absence of complete reporting of extensive statistical analysis for each dimension. However, the observation results during the learning process showed that students were more confident to accomplish GIS tasks with different complexity, more persistent in facing difficulties and more willing to apply acquired skills to broader learning situations.

The rise in students' self-efficacy could also be explained by the reflection exercises that were part of the intervention. Students were encouraged to examine their own learning progress through self-evaluation and peer assessment exercises, discover strengths and weaknesses, and improve subsequent performance. Prior research shows that reflective learning and collaborative feedback can foster self-regulation and confidence in academic settings (Yan et al., 2025).

The outcomes of this study are consistent with previous empirical studies that found the favourable correlations between Project-Based Learning and students' motivation, engagement, teamwork, and self-confidence (Tia & Wangid, 2024). Previous studies have indicated that PjBL can boost active learning experiences and increase students' involvement in real problem-solving tasks. Peer tutoring research also reports that engagement and collaborative help from peers can have positive effects on academic confidence and conceptual knowledge especially in courses that are practical and task-oriented (Seevaratnam et al., 2023). Collaborative project work and peer support within the GIS learning process can provide students with substantial opportunity to build their academic confidence as well as their technical skills.

However, various other potential hypotheses should also be considered in interpreting the results. The perceived improvement may not be merely the consequence of the intervention itself. Other factors may have also contributed to the higher posttest scores, including testing effects, increased familiarity with the

questionnaire, maturation over the semester, course progression, instructor influence, social desirability bias, and increased familiarity with GIS tasks and learning environments. Because there was no comparison group in the study, these characteristics could not be properly controlled.

Limitations

This study is not without limitations that need to be noted. The first is the use of a one-group pretest-posttest design without a control group which limits the capacity to make causal conclusions about the effectiveness of the intervention. Second, the sample size was rather small and consisted of students from one study program, which could restrict the generalisability of the results to larger educational settings. Third, the study relied on self-report questionnaire data, which may be subject to response bias and social desirability. Fourth, the complete quantitative analyses for each dimension of self-efficacy (level, strength, and generality) were not fully given, limiting the interpretation of dimension-specific increases.

Future research are encouraged to use experimental or quasi-experimental designs including control groups, larger and more diverse populations, and longitudinal observations to enhance internal and external validity. Furthermore, future research should include more detailed analyses of the dimensions of self-efficacy and should collect qualitative data such as interviews and focus group discussions to gain a better understanding of the students' learning experiences during the implementation of peer tutoring-based Project-Based Learning .

CONCLUSION

The results of this study suggested that the Project-Based Learning model with peer tutoring was related to a rise in students' overall self-efficacy scores during the preliminary implementation. The improvement seen implies that collaborative project activities and peer contact may enhance students' confidence and involvement toward completion of academic tasks in the GIS learning environment. However, conclusions should be regarded with caution as the study used a one-group pretest–posttest design without a control group, restricting the capacity to determine causal effectiveness.

Although the study related to the dimensions of level, strength and generality conceptually, findings on these dimensions are tentative because all extensive and detailed dimension-specific statistical analyses were not given. Therefore, the results mostly show an improvement in the overall self-efficacy and not clear gains in each area.

In addition, assertions about the model's viability and practicality need to be considered in the context of a preliminary experiment and without complete data from full validation, observational, and formative evaluation. However, the research provides preliminary evidence that the combination of peer tutoring and Project-Based Learning as a collaborative learning technique in higher education has potential.

Future work should include larger samples, control or comparison groups and longitudinal approaches to strengthen internal and external validity. Further research needs to be conducted to investigate the effect of the learning model on the specific dimension of self-efficacy, as well as other factors such as student engagement, learning motivation, well-being, academic anxiety, and collaboration abilities, in order to have a more complete picture of the influence of the learning model.

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Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

The study protocol adhered to the principles outlined in the Declaration of Helsinki, which provides guidelines for ethical research involving human participants. Ethical considerations in this study were that participation was entirely optional.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

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Authors' Contributions

All authors equally contribute to this study.

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