**Cakrawala Pendidikan**
**Jurnal Ilmiah Pendidikan**
Vol. 43 No. 1, February 2024, pp.262-272
https://journal.uny.ac.id/index.php/cp/issue/view/2613
DOI: https://doi.org/10.21831/cp.v43i1.60380

# Building the foundation for creativity and collaboration: Knowledge sharing learning models

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**ABSTRACT**

The integration of creativity, critical thinking, collaboration, and communication skills into 21st-century learning represents a pivotal goal in education, particularly within the realms of engineering. Despite this ambition, the actualization of creativity and collaborative capabilities among engineering students remains a significant challenge, primarily due to prevalent individualistic attitudes and apprehensions towards error in idea sharing. This study introduces and evaluates a Knowledge Sharing (KS) learning model aimed at overcoming these barriers, thereby facilitating enhanced creativity and collaboration. Employing the Akker learning stages, this model was implemented in an engineering education setting, yielding encouraging outcomes: students demonstrated increased motivation for interdisciplinary learning, acquired novel knowledge beyond their traditional curricula, and developed practical designs and tools responsive to community needs. The methodology section details the iterative process of model development, encompassing identification, design and preparation, implementation, replication, and dissemination phases, followed by a thorough validation process. Results indicate a positive impact on students' creative competencies and collaborative skills, underscoring the model's efficacy in fostering essential 21st-century skills.

**Keywords:** learning models, knowledge sharing, collaboration, creativity, engineering education

**Article history**

| *Received:* | *Revised:* | *Accepted:* | *Published:* |
|---|---|---|---|
| *30 May 2023* | *20 October 2023* | *13 January 2024* | *28 February 2024* |

**Citation (APA Style):** Mustaqim, I., Setyosari, P., Kamdi, W. & Ulfa, S. (2024). Building the foundation for creativity and collaboration: Knowledge sharing learning models. *Cakrawala Pendidikan: Jurnal Ilmiah Pendidikan*, *43*(1), 262-272. DOI: https://doi.org/10.21831/cp.v43i1.60380

## INTRODUCTION

In general, students' creativity and collaboration in innovating around the world still face obstacles. Twenty-five Global Trade and Innovation Policy Alliance members, including Malaysia, Switzerland, Sweden, Canada, India, and the Philippines, also feel this way (Global Trade and Innovation Policy Alliance, 2019). Universities must transfer knowledge to support creative problem solving and collaboration in universities. Because students practice more, Knowledge Sharing (KS) in engineering education is still difficult. These obstacles underscore the urgent need for universities to facilitate effective KS to bolster creative problem-solving and collaboration (Chamidy et al., 2020; Yunus et al., 2021). However, KS in engineering education is challenged by prejudice and individualism, which, alongside doubts about the competence of others, significantly hinders collaboration and limits the scope and efficiency of student work. Without knowledge sharing, student work is limited in benefits, knowledge, and manufacturing efficiency (Al-Kurdi et al., 2020). Laduca et al. (2017), report that students rarely get to design products to solve social issues. Engineering students rarely developed creative problem-solving skills.

Furthermore, universities seek to find ways to encourage student competencies to compete to meet the needs of the world of work (Richardson & Mishra, 2018). Every student is unique. Students' works are often individualistic because they don't use their potential. Students must understand that innovative products/tools require collaboration. Sharing knowledge fosters creativity and collaboration (Matzler et al., 2008). Another comparative study in Iraqi universities found that knowledge sharing increases student creativity and collaboration (Al-Husseini & Elbeltagi, 2015). Knowledge sharing is a part of knowledge management where knowledge (skills, experience, skills, information) is shared both within and across the organization. Knowledge sharing includes more than just communication, as much knowledge in an organization is difficult to articulate (Janus, 2016).

Student life also requires collaboration. Teamwork improves life skills and self-esteem. It supports them socially and helps them work more disciplined. Teamwork improves social skills and cooperation (Moore & Mann, 2020; Santosa et al., 2020). Another significant component is the experience in which students showcase their greatest work with others. They value experience because they can achieve task outcomes by working together. Teamwork is not limited to the exchange of necessary information. Team members are trained to participate in the design and development of their ideas (Setyosari et al., 2020). This can be done by exchanging ideas, providing benefits, sharing experiences and knowledge (Dávideková & Hvorecký, 2017).

Knowledge sharing also boosts creativity. Creativity increases with knowledge sharing quality. Through knowledge exchange, social ties, trust, and identification affect creativity (Suryanto et al., 2021). According to Lee (2018), the quality of information sharing should be prioritized over just encouraging students to share more knowledge in order to encourage individual creativity. He uses a socio-technical approach in his research to look at the impact of knowledge sharing on individual creativity in institutions. The results obtained are that high individual creativity through knowledge sharing contributes to innovation and team performance.

Overall, while KS predominantly targets organizational performance, its principles are equally critical across various fields, including social sciences, where they bolster research and the practical application of theories (Mahmood, Dahlan & Ahmad, 2016). This is especially relevant in engineering education, where graduates, as future educators, must embody 21st-century teaching capabilities. According to Ibrahim et al. (2019), 21st-century educators must master collaboration, communication, problem-solving, critical thinking, creativity, and technology. Teachers of engineering must understand and teach engineering. The use of technology in education, particularly in engineering, enhances students' digital literacy and device usage. Students can interact, discuss, and be creative in online discussion forums to increase their knowledge of and interest in learning science (Idris et al., 2021). Therefore, this study aims to develop and evaluate a KS learning model to cultivate creativity and collaboration among engineering students, preparing them as future educators equipped with 21st-century skills. This approach acknowledges the critical role of teamwork and digital literacy in enhancing educational outcomes and addresses the identified gap in KS model research within learning environments.

## METHOD

The instrument for developing the KS learning model encompasses five sequential phases, as adopted from Janus (2016), starting with Identification and brokering, and culminating in Dissemination. Table 1 shows the instruments used by researchers to develop the KS learning model.

The research procedure carried out in designing the knowledge sharing learning model to build creativity and collaboration adapts the stages of learning Akker (1999). Begins with the preliminary investigation stage, embedding theoretical studies, empirical testing, documentation, analysis, and reflection on processes and outputs (See Table 2). Before the trial, the validation of the learning model was conducted. The objective is to develop the validity of the model and the validity of the material. As practitioners, specialists and two professors validated the learning model with the knowledge-sharing method. This is the instrument used to develop the KS model.

Researchers used a Likert scale to assess students' creativity and teamwork. The number of samples is 25 students and provides 28 questionnaire questions about collaboration and the KS model and an assessment of student product creativity. Data analysis obtained quantitative data using scores on each instrument item using a 1-5 Likert scale and scoring.

**Table 1. Instruments for developing the knowledge sharing learning model**

| Phase | Definition | Development of KS learning model activities. |
|---|---|---|
| Identification and brokering | Create intermediary facilities to identify needs and solutions. | Students use the Lecturer (Broker) platform to develop creativity and collaboration in product/tool design. Technology supports formal and informal learning plans. Find the object's problems and solve them. |
| Design and Preparation | Assess audience, needs, and goals for each knowledge sharing activity | Students found all field issues. They have made product/tool design plans that are under community needs. |
| Implementation | Implement knowledge sharing by implementing program designs that have been agreed upon by both parties. | Students create designs and make them happen in the form of products that suit the community's needs. |
| Replication | Adapting knowledge and imitating (or improving) to achieve results | Students present the product to their colleagues, lecturers, and a team of experts. Product evaluation from colleagues, lecturers, and expert team |
| Dissemination | An interactive process in delivering innovation that ultimately changes the mindset and actions of the people involved | Students present products to the user community or partner industry. |

**Table 2. Stage of development research**

| | Development Stage | Research Activity |
|---|---|---|
| 1. | Preliminary investigation | Researchers review the KS literature, KS steps, the process of building Creativity and Collaboration |
| 2. | Theoretical embedding | Researchers use the knowledge base and findings of the KS model to design the KS model further |
| 3. | Empirical testing | Empirical evidence showing the effectiveness of the KS Model through the validation of instructional design experts and practitioners |
| 4. | Documentation, analysis, and reflection on process and outcome | Documentation, analysis, and evaluation of the entire design development, evaluation, and implementation process contribute to the advancement and specification of design and development research methods. |

## FINDINGS AND DISCUSSION

### Findings

***Preliminary investigation and theoretical embedding***

The KS learning model encourages students to work together creatively and collaboratively through the use of the KS model stages. This model was originally proposed by Janus (2016). Using Bloom's taxonomy, each sub-section is its own learning activity, which is then evaluated to determine whether or not the student has achieved the desired level of competence. The KS model, which includes the flow that was developed from the KS phase, provides direction for the building of creativity and collaboration. See Figure 1.

The first thing that needs to be done is to find potential participants and negotiate deals with them. At this stage in the procedure, the introductory activities are carried out, beginning with the courses, then moving on to the explanation of assignments, the evaluation of courses, and finally the subsequent division of teams. The primary objective of this stage is to ensure that students are aware of the information that will be learned and obtained during learning, as well as the activities that will be carried out during learning and the methods that can be used to achieve learning achievement.

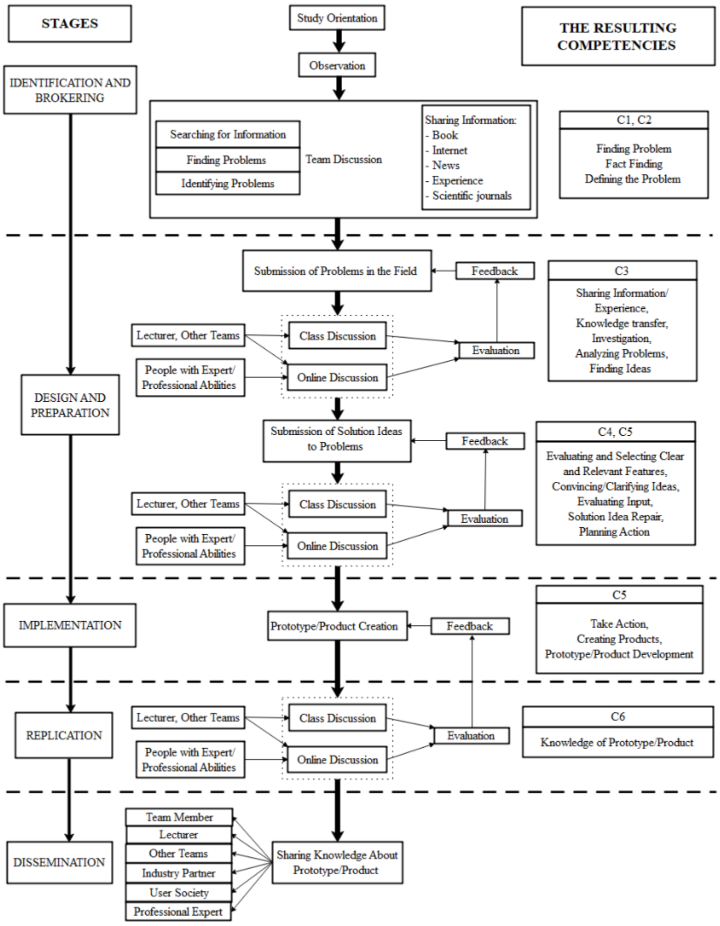


**Figure 1. Knowledge Sharing Learning Model Design**

Another goal of this stage is to ensure that students are aware of the activities that will be carried out during learning and the methods that can be used to achieve learning achievement.

When we get to this point in the training, the instructor will divide the class into several different groups or into smaller teams, depending on the activity. Every single group has an individual who has been given the role of leader. The leader of each team is responsible for directing the conversation that takes place within their group regarding the various tasks that are being worked on. This conversation can be about anything related to the tasks that are being completed.

Every group will now start talking to one another in order to get themselves ready for the next stage, which will consist of making observations. The responsibility for preparing the various learning support tools, including the media that will be utilized, lies with the instructors who oversee teaching the course. Support for the implementation of online learning can originate from a wide variety of sources, including the utilization of a Learning Management System (LMS), various forms of social media (such as WhatsApp and Telegram), and other resources that are analogous to one another. Students are made aware of this option so that they may select it and reach an understanding with one another in accordance with the conditions that make it possible for online education to be carried out in a timely manner that is also smooth and effective. This is done to ensure that the conditions that enable effective and efficient online learning to be carried out are met, as they are necessary in order for online learning to be carried out at all.

In addition, students take part in activities that require them to make observations about the world around them. In the past, the group had been subdivided into conventional classes for the purpose of making conversation easier and accelerating the process of developing plans for field trips to nearby businesses or communities. The members of the team will engage in conversation to ascertain both the location and the object that will serve as the focus of the subsequent observation. During the process of team discussion, individual members of the team contribute their own ideas and thoughts for consideration based on the information and experience that they have. The group will first determine the problems that are present in the object of observation, and then, utilizing the knowledge that they have, they will work to find solutions to these problems using the information that they have. After that, the group went out into the field to investigate the actual conditions that the community or the requirements of the industry were. The findings of field observations are supplemented with additional information obtained from a wide variety of sources, such as reference books, scientific journals, news articles, and a great deal of other kinds of publications and sources of information. At this point in the process, the most important objective is to impart information and knowledge on students in such a way that it is directly relevant to their own experiences. Students will be able to acquire tacit knowledge through this process, which they will subsequently be able to pass on to other students in subsequent stages.

Knowledge is transferred from one person to another during the planning and preparation stages, which ultimately results in the formation of tacit knowledge because of direct experience. As a direct consequence of this change in knowledge, the form of tacit knowledge will morph into the form of explicit knowledge. The team that visited the community in order to gather information has set as their primary objective the investigation of the myriad problems that are present in the location that is the focus of the observation. The team shared their findings not only with the other groups in the class but also with the rest of the class when they were in the classroom. They are able to communicate the experiences that they had while observing, the fact-finding conditions that they encountered while out in the field, as well as their explorations from a variety of different study sources. In addition to concept maps, the information that has been gathered has been organized into presentations, and these presentations make use of presentation slides.

Everyone on the team takes turns discussing their personal experiences and the things they've picked up from working on their knowledge side. The responses of the other teams in the class, whether in the form of questions, suggestions, or additional information to supplement what they have learned, will be given after what has been said. A conversation is going to be held for this purpose. In order to communicate ideas or solutions to problems that are experienced in the field, activities are carried out in accordance with the plan that was developed by researchers.

After the idea or potential solution has been presented to the group in the classroom, members of the group continue their conversation with one another about the topic. The explicit knowledge that has been amassed up to this point is currently in the process of being organized into a more methodical form of media by the addition of new knowledge, the combination of existing knowledge, and the categorization of the information that has been amassed. The application of these concepts in learning design is carried out to deliver ideas or solutions to problems that were analyzed in the stage prior to this one, as well as to create prototypes or products. Additionally, this application of these concepts is carried out to create learning environments. Both procedures are supplemented with discussions and presentations that take place in the classroom as well as over the internet.

During the stage of implementation, the team has conversations with both other teams and a team of experts or practitioners in order to obtain a variety of inputs. The goal of these conversations is to collect as much information as possible. The data that has been gathered is then organized and put to use in the form of a prototype or product in order to evaluate its effectiveness. If the method of processing the product requires the use of specialized hardware, the lecturer will either lead a workshop or a laboratory to demonstrate how to use the equipment. Even if the necessary piece of equipment is not available on campus, it may still be possible to collaborate with a group of specialists located off campus or with members of the public.

The process of making the product is carried out during the stage of replication by participating in online conversation and studying in a traditional classroom setting. The researchers who worked on the KS model developed it further by adding dissemination, which is the process of spreading ideas or ideas derived from products that students have created. This was done in order to complete the stages of the KS model that are shown in table 1.

The tacit form of knowledge is formed when the explicit form of the information is transformed into it during the stage of dissemination. This happens because of learning by doing, which is a process that results in the individual developing new knowledge within themselves. A KS learning model has been proposed by the researcher at this stage of the process. This model describes both the product and its application in real-world scenarios that take place out in the field. This product description includes all the stages of the product processing process, as well as the product testing process, product usage practices, product performance exposure, and product evaluation. Students can apply the knowledge that they have gained from working together to gain tacit knowledge and indirect experience in the process of product creation. This allows students to gain both direct and indirect experience. The students gain valuable experience in applying the knowledge that has been obtained by turning it into valuable products according to the challenges that are encountered in the field. This gives the students a significant advantage in their professional development. At this stage of the production process, users and the general public are provided with additional information regarding the final product. The improvement of the tacit knowledge that has been obtained is going to be made explicit using this exercise, which is going to be its purpose.

***Empirical testing***

The Validator believes that the KS learning model has the potential to foster creative thinking and teamwork, which can then be used to establish communication and cooperation with the stakeholders of potential users. Students are given the opportunity to discover their full potential by working with others, both on and off campus, in collaborative projects. The suggestions made by validators call for the establishment of Standard Operating Procedures (SOP) for KS to ensure that outputs and outcomes correspond to learning outcomes. In addition, the implementation of it must ensure the existence of a learning model that schools can apply to prepare for the fourth to fifth wave of the industrial revolution. Table 3 demonstrates the validation results that were obtained for the KS learning model.

Table 3 displays the Confirmatory Factor Analysis (CFA) factor loadings and t-values for the items across each scale. The fit indices for the questionnaire scales ($X^2 = 693.12$ [$p < 0.001$], $RMSEA = 0.05$, $GFI = 0.88$, $NFI = 0.94$, $CFI = 0.91$) suggest an adequate model fit, further affirming the structure of the questionnaire. Furthermore, the average variance extracted (*AVE*) values varied between 0.54 and 0.77, surpassing the minimum threshold of 0.5, thereby affirming the model's adequacy. Cronbach's Alpha values for the KS (0.93), Collaboration (0.75), and Creativity (0.78) scales all surpass the 0.70 benchmark, attesting to the constructs' reliability (Cohen, 1988). This means that the instrument is relevant, in the sense that it can be applied to students by incorporating the comments and recommendations of professionals. In addition to this, the researchers examined the effectiveness of the tool on a group of twenty-five different students.

According to Table 4, students' ability to impart knowledge falls into the high category with a score of 44%, and very high with a score of 36%. According to the findings, the majority of students have the ability to collect knowledge, contribute knowledge, communicate with others, and consult with colleagues to share intellectual capital.

An evaluation of the students' creative potential can be found in table 5. According to the findings, 56 percent were rated as very good, while 40 percent were rated as good. The following conclusions can be drawn based on the creativity indicators, which include creative problem-oriented design, function, product, and form: Students have the opportunity to develop skills in problem-solving, design products, investigate and improve product functionality, and market and produce new products both in terms of the shape, format, and appearance of a product. Students can also produce new products by ensuring that these items have usability and a positive public image. According to the findings of this study, which are in line with research conducted by Chandrasekaran & Al-Ameri (2016) it has been found that when students study together in a team setting, it enables them to achieve shared learning goals.

**Table 3. Validation results for the knowledge sharing learning model**

| Scales | Component | Item | Mean | SD | Factor loading | T-value | Cronbach Alpha |
|---|---|---|---|---|---|---|---|
| Knowledge Sharing | Donate | KS1 | 3.67 | 0.95 | 0.81 | 17.94*** | 0.93 |
| | | KS2 | 3.56 | 0.83 | 0.75 | 15.17*** | |
| | | KS3 | 3.39 | 0.89 | 0.92 | 18.73*** | |
| | | KS4 | 3.95 | 0.82 | 0.72 | 15.85*** | |
| | | KS5 | 3.60 | 0.80 | 0.82 | 19.21*** | |
| | Collecting | KS6 | 3.73 | 0.78 | 0.89 | 17.13*** | |
| | | KS7 | 3.12 | 0.95 | 0.76 | 19.22*** | |
| | | KS8 | 3.78 | 0.79 | 0.83 | 17.90*** | |
| | | KS9 | 3.77 | 0.81 | 0.73 | 18.12*** | |
| | | KS10 | 3.78 | 0.86 | 0.84 | 16.57*** | |
| Collaboration | Openness and Communication | CB1 | 4.14 | 1.00 | 0.76 | 19.72*** | 0.75 |
| | | CB2 | 3.85 | 0.78 | 0.74 | 17.56*** | |
| | Share Knowledge and Skills | CB3 | 3.50 | 1.00 | 0.82 | 16.04*** | |
| | | CB4 | 3.58 | 0.78 | 0.70 | 17.30*** | |
| | Share Risk and Reward | CB5 | 3.87 | 1.04 | 0.87 | 13.24*** | |
| | | CB6 | 3.17 | 0.89 | 0.68 | 15.19*** | |
| | Trust | CB7 | 3.83 | 1.04 | 0.84 | 17.67*** | |
| | | CB8 | 3.84 | 0.93 | 0.75 | 15.11*** | |
| | Loyalty | CB9 | 3.33 | 0.97 | 0.85 | 17.38*** | |
| | | CB10 | 3.24 | 0.76 | 0.89 | 16.07*** | |
| Creativity | Problem-Oriented Creative Design | CR1 | 3.45 | 0.83 | 0.75 | 14.05*** | 0.78 |
| | | CR2 | 3.50 | 0.79 | 0.82 | 15.17*** | |
| | Function-Oriented Creative Design | CR3 | 3.73 | 0.84 | 0.82 | 17.05*** | |
| | | CR4 | 3.58 | 0.79 | 0.81 | 17.19*** | |
| | Product-Oriented Creative Design | CR5 | 4.19 | 0.85 | 0.74 | 17.08*** | |
| | | CR6 | 3.21 | 0.87 | 0.89 | 17.62*** | |
| | Shape-Oriented Creative Design | CR7 | 3.33 | 0.77 | 0.79 | 17.62*** | |
| | | CR8 | 3.28 | 0.96 | 0.87 | 16.09*** | |

*Notes* $N = 25$, $X^2 = 693.12$ ($p < 0.001$), *RMSEA* 0.05, *GFI* 0.88, *NFI* 0.94, *CFI* 0.91
*** $p < 0.001$

**Table 4. Percentage of students' ability to share knowledge**

| Percentage of students' ability to share knowledge | | | |
|---|---|---|---|
| Category | Interval | Frequency (f) | Percent (%) |
| Very High | 43-50 | 9 | 36 |
| High | 35-42 | 11 | 44 |
| Moderate | 26-34 | 3 | 12 |
| Low | 18-25 | 2 | 0 |
| Very Low | Oct-17 | 0 | 0 |

Knowledge sharing, analysis skills, presentation skills, communication skills, time management, and task management are all improved because of the process that they go through while working together in teams.

**Table 5. Percentage of creativity value**

| Percentage of Creativity Value | | | |
|---|---|---|---|
| Category | interval | Frequency (f) | Percent (%) |
| Excellent | 81-100 | 14 | 56 |
| Very good | 66-80 | 10 | 40 |
| good | 56-65 | 1 | 4 |
| Fair | 41-55 | 0 | 0 |
| Poor | 0-40 | 0 | 0 |

Furthermore, the results of table 6 demonstrate that the students' ability to collaborate ranks high overall, with 68% of them falling into the high category and 16% landing in the very high category. According to the findings, students have the ability to improve their openness and communication, share their knowledge and skills, share both risks and rewards, join learning groups, build trust, and remain loyal. According to the findings of this study, students can develop their self-esteem and social skills with the help of their peers and the community, which also provides them with professional and social support. This is in line with the importance of links in terms of establishing trust and developing one's own self-confidence while attending college. The findings indicate that teachers, other students, and the community all play an important part in the communication networks of students. According to findings from earlier studies presented by Yusof et al (2020), which state that with support from their peers and the community, students can cultivate positive mindsets, openness, and communication, as well as develop a strong character, we can say that.

**Table 6. Percentage of students' ability to collaborate**

| Percentage of Students' Ability to Collaborate | | | |
|---|---|---|---|
| Category | interval | Frequency (f) | Percent (%) |
| Very High | 43-50 | 4 | 16 |
| High | 35-42 | 17 | 68 |
| Moderate | 26-34 | 4 | 16 |
| Low | 18-25 | 0 | 0 |
| Very Low | Oct-17 | 0 | 0 |

***Documentation, analysis, reflection on processes and results***

The discovery that the establishment of knowledge sharing will also build the foundation of student creativity and collaboration was made based on the implementation of the development of the KS model, which led to the discovery of this fact. The KS learning model is able to function without hindrance as a result of an agreement reached between the lecturers and the students, in addition to Standard Operating Procedures and learning contracts.

Because students can build creativity and collaborate through the use of a team of experts and the user community, it is possible for them to overcome the limited knowledge that each student initially possessed. One more thing that we discovered was that the ideas for making a product that emerged from all of the different student groups shared some similarities. However, when the concept was actualized in the form of a product in response to the requirements of the community, it turned out to have different results in terms of the orientation toward function, the orientation toward product, and the orientation toward shape. The environment, financial capacity, the support of technology, and the limited knowledge of the community are all factors that can influence the difference in results.

Figure 2 showcases an exemplary application of engineering principles by students: an automatic plant sprinkler created using Internet of Things (IoT) technology on a smartphone device. This project, implemented at a local tourist attraction in response to community needs, exemplifies how engineering education encourages students to apply their knowledge and skills to develop innovative solutions for real-world challenges. Such practical applications highlight the integration of theory and practice in engineering curricula, demonstrating the direct impact of academic learning on community and industry.

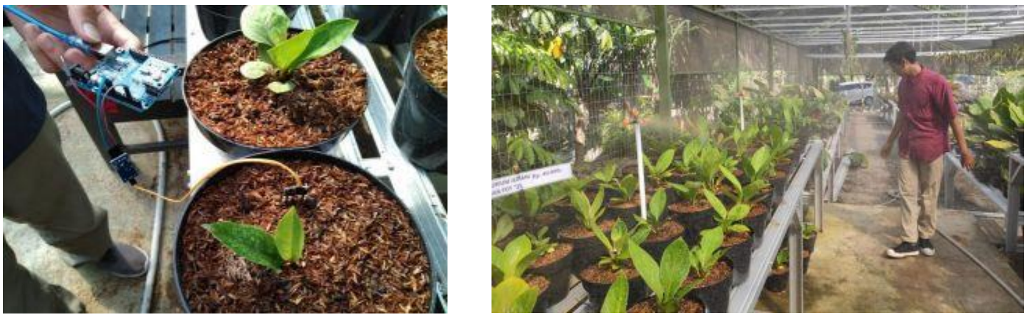

**Figure 2. IoT-based Automatic Plant Watering Product Results**

It is to the benefit of students to acquire as many different skill sets as possible, particularly those that will help them transition successfully into the working world. Students will be more likely to succeed in a competitive environment if they share their knowledge and help one another and their teams better utilize knowledge-based resources (Cabrera & Cabrera, 2005; Davenport & Prusak, 2000; Jackson et al., 2015). The most significant factor that has a significant impact on creative output and product innovation is the sharing of relevant information. Management of an organization is required for the sharing of knowledge in order to facilitate the transfer of information, experience, and skills as well as the generation of new information and ideas (Cabrera & Cabrera, 2005). It is essential to have collaboration between groups both on and off campus in order to develop individuals who have greater creative abilities (Shalley et al., 2004).

## CONCLUSION

The development of the KS Model aims to foster creativity and collaboration among students, particularly in engineering education. This research generates creative and innovative KS models, learning SOPs, and student products. Through the KS model, the significance of a team of experts and stakeholders can also serve as a foundation for collaboration. To increase their field competence, students are more confident in communicating ideas, interacting with others, and attempting new things outside of their knowledge base. The implementation of the KS model can build a foundation of creativity and collaboration for students under the required 21st-century competencies, as recommended by several experts.

This research focuses solely on fostering students' creativity and collaboration in engineering education. In subsequent/further research, the researcher analyzes the specifics of the students' problem-solving process when sharing knowledge, establishing teamwork, and interacting with external parties. In addition, additional research is required regarding students' creative thinking abilities when expressing product ideas in response to community needs. The trial sample of several students can then be applied to a larger number of students so that the results can be generalized to a larger number of students.

## ACKNOWLEDGEMENT

This research was supported by the Domestic Postgraduate Education Scholarship Program (BPPDN) from the Ministry of Education, Culture, Research, and Technology.

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