

Community Engagement for Educational Innovation: Implementing the SOLO Taxonomy to Foster Higher-Order Learning at Yala Rajabhat University, Thailand

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Abstract.

Community engagement plays an important role in promoting educational innovation and enhancing higher-order learning in higher education. This community engagement program aimed to introduce and implement the Structure of the Observed Learning Outcome (SOLO) Taxonomy to support students' higher-order thinking skills at Yala Rajabhat University, Thailand. The program was delivered through an international academic collaboration involving interactive lectures, collaborative discussions, case-based learning, and practical activities focused on designing learning tasks using the SOLO Taxonomy. Program effectiveness was evaluated using pre- and post-program assessments, participant observations, reflective feedback, and satisfaction questionnaires. The results indicated improved understanding of the SOLO Taxonomy and greater ability among participants to design and analyze learning activities that promote relational and extended abstract thinking. Participants also reported increased confidence in applying reflective and critical thinking strategies within academic contexts. Overall satisfaction with the program was very high, highlighting the relevance of the training materials, interactive learning approach, and opportunities for international academic exchange. These findings demonstrate that community engagement based on the SOLO Taxonomy provides an effective strategy for fostering higher-order learning, strengthening pedagogical competence, and supporting educational innovation in higher education through international collaboration.

Keywords: *Community engagement, SOLO Taxonomy, higher-order learning, educational innovation and higher education.*

I. INTRODUCTION

Higher education institutions are increasingly expected to prepare graduates who possess higher-order thinking skills, including critical thinking, problem solving, creativity, and reflective learning. These competencies are essential for addressing the complex challenges of the twenty-first century and are recognized as key outcomes of quality higher education [1]. Consequently, universities are encouraged to adopt innovative pedagogical approaches that move beyond the transmission of factual knowledge toward meaningful learning experiences that promote deep understanding and independent inquiry.

One instructional framework that supports this objective is the Structure of the Observed Learning Outcome (SOLO) Taxonomy developed by Biggs and Collis [2]. The SOLO Taxonomy classifies learning outcomes into five progressive levels, prestructural, unistructural, multistructural, relational, and extended abstract, providing educators with a systematic framework for designing learning activities and assessments that encourage increasingly sophisticated cognitive development. Unlike approaches that primarily emphasize knowledge acquisition, the SOLO Taxonomy focuses on the quality of students' understanding and their ability to integrate, analyze, and apply knowledge in authentic contexts. As a result, it has been widely recognized as an effective framework for fostering higher-order learning and improving instructional quality [3].

Community engagement has emerged as an important strategy for bridging academic knowledge and educational practice. In higher education, community engagement extends beyond community service by emphasizing reciprocal partnerships, knowledge exchange, and collaborative capacity building among universities and partner institutions [4]. International community engagement initiatives provide opportunities for educators and students to exchange innovative teaching practices, strengthen pedagogical

competencies, and develop cross-cultural perspectives that enrich learning experiences [5]. Such collaborations also contribute to the internationalization of higher education by promoting academic networking and the dissemination of evidence-based educational innovations.

Despite the growing recognition of higher-order learning, the practical implementation of the SOLO Taxonomy remains limited in many higher education contexts, particularly within international community engagement programs [6]. Many students remain unfamiliar with learning strategies that foster relational and extended abstract thinking, while educators often need practical guidance on integrating the taxonomy into classroom instruction and assessment [7]. This gap highlights the need for professional learning activities that combine theoretical understanding with practical application through collaborative engagement.

To address this need, an international community engagement program was conducted at Yala Rajabhat University, Thailand. The program introduced the principles of the SOLO Taxonomy through interactive lectures, collaborative discussions, reflective activities, and practical workshops designed to help participants apply the taxonomy in learning design and assessment. By engaging students and lecturers in active learning experiences, the program sought to strengthen their understanding of higher-order learning and encourage the adoption of innovative instructional practices.

This article reports the implementation and outcomes of the community engagement program. Specifically, it describes the educational activities conducted, evaluates participants' responses and perceived learning outcomes, and discusses the contribution of the SOLO Taxonomy as a pedagogical framework for fostering higher-order learning through international collaboration. The findings are expected to provide practical insights for higher education institutions seeking to enhance educational innovation, strengthen academic partnerships, and promote meaningful learning experiences in diverse educational settings.

II. METHODS

Research Design

This study employed a descriptive community engagement approach to evaluate the implementation of an educational innovation program introducing the SOLO Taxonomy at Yala Rajabhat University, Thailand. The program was conducted as part of an international academic collaboration between higher education institutions to strengthen pedagogical competence and promote higher-order learning. A mixed-method evaluation design was adopted to obtain comprehensive evidence regarding participants' learning experiences, combining quantitative measures of participant satisfaction and perceived learning outcomes with qualitative reflections on program implementation [8].

Participants

The participants comprised 80 individuals from Yala Rajabhat University, including 68 undergraduate students across various academic disciplines and 12 lecturers who voluntarily participated in the community engagement program. Participants were selected through purposive sampling based on their interest in educational innovation and active involvement in teaching and learning activities [9]. Prior to the program, all participants were informed of the objectives and procedures of the activity and provided consent for their responses to be used anonymously for research and publication purposes.

Program Implementation

The community engagement program was implemented over one full day and consisted of four sequential phases. The first phase introduced participants to the theoretical foundations of higher-order learning and the SOLO Taxonomy through an interactive lecture. The second phase involved collaborative discussions and case analyses to explore the characteristics of the five SOLO levels, prestructural, unistructural, multistructural, relational, and extended abstract, and their application in higher education. During the third phase, participants worked in small groups to design learning activities and assessment tasks aligned with the SOLO framework. The final phase consisted of group presentations, reflective discussions, and feedback sessions facilitated by the community engagement team to encourage participants to evaluate and improve their instructional designs.



Fig. 1. Program Implementation

Data Collection

Data were collected using multiple sources to enhance the credibility of the evaluation. Quantitative data were obtained through a post-program questionnaire consisting of Likert-scale items measuring participants' perceptions of program quality, relevance of learning materials, instructional delivery, and perceived improvement in higher-order learning. Qualitative data were gathered through direct observations during learning activities, participants' written reflections, and field notes recorded by the facilitators. These data provided complementary information regarding participant engagement, collaborative learning processes, and the practical application of the SOLO Taxonomy.

Data Analysis

Quantitative data were analyzed using descriptive statistics, including frequencies, percentages, means, and standard deviations, to summarize participants' responses to the evaluation questionnaire. Qualitative data from observations and reflective responses were analyzed using thematic analysis. The analysis involved data familiarization, coding, categorization, theme development, and interpretation to identify recurring patterns related to participants' learning experiences, perceptions of the SOLO Taxonomy, and the perceived benefits of the community engagement program. The integration of quantitative and qualitative findings enabled a comprehensive evaluation of the effectiveness of the program in fostering higher-order learning and supporting educational innovation at Yala Rajabhat University.

III. RESULTS

Implementation of the Community Engagement Program

The community engagement program was successfully implemented at Yala Rajabhat University, Thailand, with the participation of 68 undergraduate students and 12 lecturers. All planned activities were completed according to the program schedule, including the introductory lecture, collaborative discussions, group workshops, presentations, and reflection sessions. Participants actively engaged in each learning activity and demonstrated enthusiasm for exploring innovative instructional approaches based on the SOLO Taxonomy.

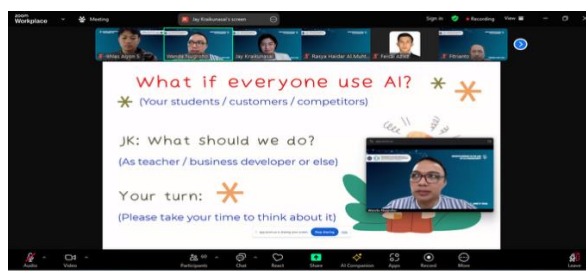


Fig. 2. Implementation of Community Engagement

During the introductory session, participants gained an understanding of the five hierarchical levels of the SOLO Taxonomy and their role in promoting meaningful learning. Interactive discussions enabled participants to compare traditional learning approaches with learning activities designed to foster relational and extended abstract thinking. The workshop sessions provided opportunities for participants to apply these concepts by developing learning tasks and assessment questions aligned with different SOLO levels.

Participants' Learning Outcomes

The program contributed to noticeable improvements in participants' understanding of higher-order learning and the practical application of the SOLO Taxonomy. Throughout the workshop activities, participants demonstrated the ability to distinguish among the five SOLO levels and appropriately classify learning outcomes according to cognitive complexity.

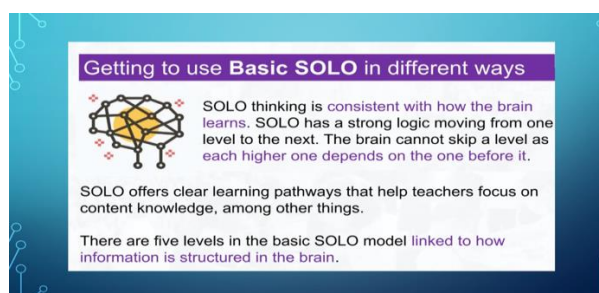


Fig. 3. Students' Learning Outcomes

Group presentations indicated that most participants were able to design learning activities that encouraged analysis, integration of concepts, problem-solving, and knowledge transfer to new situations. Compared with the initial discussions, participants' final instructional designs reflected a deeper understanding of how the SOLO Taxonomy can be integrated into teaching practices to support meaningful learning.

Reflection sessions also revealed increased confidence among participants in designing student-centered learning experiences. Many participants reported that the SOLO Taxonomy provided a practical framework for improving lesson planning, developing authentic assessments, and encouraging reflective learning in higher education classrooms.

Participant Engagement and Collaborative Learning

A notable outcome of the program was the high level of participant engagement throughout the activities. Students and lecturers actively collaborated during group discussions, exchanged perspectives, and jointly solved instructional design problems. The international setting of the program further promoted cross-cultural academic interaction, allowing participants to share diverse educational experiences and teaching practices.



Fig. 4. Collaborative Learning

Facilitator observations showed that collaborative learning encouraged participants to justify their reasoning, provide constructive feedback to peers, and revise their instructional designs based on discussion outcomes. These activities reflected the characteristics of higher-order learning, particularly at the relational and extended abstract levels of the SOLO Taxonomy.

Program Evaluation

Participant feedback indicated a highly positive evaluation of the community engagement program. The majority of participants expressed satisfaction with the relevance of the training content, the interactive learning methods, and the practical workshop activities. Participants appreciated the balance between theoretical explanation and hands-on practice, which enabled them to directly apply the SOLO Taxonomy in educational contexts.

Reflective comments suggested that the program broadened participants' understanding of educational innovation and inspired them to adopt more learner-centered instructional strategies. Lecturers emphasized that the SOLO Taxonomy could be integrated into curriculum planning and classroom assessment, while students recognized its usefulness in organizing knowledge, strengthening critical thinking, and improving academic performance.



Fig. 5. Program Evaluation

Overall, the findings demonstrate that the community engagement program successfully introduced the SOLO Taxonomy as an effective pedagogical framework for fostering higher-order learning. The combination of interactive instruction, collaborative practice, and reflective discussion created meaningful learning experiences that supported pedagogical innovation and strengthened international academic collaboration at Yala Rajabhat University.

IV. DISCUSSION

The findings demonstrate that the community engagement program successfully introduced the SOLO Taxonomy as an effective pedagogical framework for fostering higher-order learning among students and lecturers at Yala Rajabhat University. Participants showed increased understanding of the hierarchical levels of learning outcomes and were able to apply the taxonomy when designing learning activities and assessment tasks. These outcomes suggest that community engagement can serve not only as a means of knowledge dissemination but also as a collaborative platform for strengthening pedagogical capacity through active participation and international academic exchange [10].

The positive learning outcomes observed in this program are consistent with the theoretical foundations of the SOLO Taxonomy, which emphasizes progressive cognitive development from surface understanding to deep conceptual learning [11]. Through collaborative discussions, case analyses, and reflective activities, participants gradually developed the ability to connect ideas, integrate knowledge, and transfer learning to authentic educational contexts. This progression reflects the relational and extended abstract levels of the SOLO framework, where learners construct meaningful relationships among concepts and apply their knowledge to solve new problems. Such learning experiences are fundamental to developing higher-order thinking skills required in contemporary higher education.

The high level of participant engagement also highlights the value of interactive and collaborative learning environments. Rather than receiving information passively, participants actively discussed educational challenges, exchanged experiences, and jointly developed instructional designs [12]. These activities encouraged reflection, communication, and collaborative problem-solving, all of which are recognized as essential components of learner-centered education. The findings therefore support the view that educational innovation is more likely to succeed when participants are actively involved in constructing knowledge and reflecting on their own learning practices.

An important contribution of this program lies in its international community engagement context. The collaboration between universities from different countries created opportunities for intercultural dialogue and the exchange of pedagogical perspectives [13]. Such interactions enriched participants' understanding of teaching practices beyond their local educational context and strengthened international academic partnerships. Community engagement initiatives of this nature contribute not only to professional development but also to the broader internationalization agenda of higher education by encouraging the sharing of educational innovations across institutions.

The findings further suggest that the SOLO Taxonomy offers practical benefits for both lecturers and students. For lecturers, the framework provides clear guidance for designing learning outcomes, instructional activities, and authentic assessments that progressively develop students' cognitive abilities. For students, understanding the taxonomy enables greater awareness of learning expectations and encourages reflective

learning strategies that extend beyond memorization toward analysis, synthesis, and knowledge creation. Consequently, the SOLO Taxonomy may function as both an instructional planning tool and a learning framework that supports continuous cognitive development [14].

Despite these positive outcomes, several limitations should be acknowledged. The program was conducted at a single institution with a relatively limited number of participants and was evaluated immediately after implementation. Therefore, the findings primarily reflect participants' perceptions and short-term learning outcomes rather than long-term changes in teaching practice or student achievement. Future community engagement initiatives should incorporate longitudinal evaluation, classroom implementation studies, and broader institutional participation to examine the sustainability and wider impact of SOLO Taxonomy-based educational innovation [2].

Overall, this community engagement program demonstrates that integrating the SOLO Taxonomy into international academic collaboration provides a meaningful approach to promoting higher-order learning, strengthening pedagogical competence, and supporting educational innovation in higher education. The program offers a practical model that can be adapted by other universities seeking to enhance learning quality through collaborative engagement and evidence-informed teaching practices.

V. CONCLUSION

The community engagement program demonstrated that implementing the SOLO Taxonomy is an effective strategy for promoting higher-order learning and supporting educational innovation in higher education. Through interactive lectures, collaborative discussions, practical workshops, and reflective activities, participants developed a deeper understanding of the SOLO Taxonomy and its application in designing learning activities and authentic assessments. The program also fostered active participation, collaborative learning, and cross-cultural academic exchange, highlighting the value of international community engagement in strengthening pedagogical competence.

The findings suggest that the SOLO Taxonomy provides a practical framework for enhancing teaching and learning by encouraging students to progress from surface-level understanding to relational and extended abstract thinking. Moreover, the international collaboration between higher education institutions contributed to the dissemination of innovative teaching practices and reinforced the role of community engagement in supporting the internationalization of higher education. Future community engagement initiatives should expand the implementation of the SOLO Taxonomy across different disciplines and institutions while incorporating longitudinal evaluation to examine its long-term impact on teaching practices and student learning outcomes. Such efforts will contribute to the continuous improvement of educational quality and the development of higher-order thinking skills in diverse higher education contexts.

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REFERENCES

- [1] L. F. Claudia, T. A. Kusmayadi, and L. Fitriana, "The SOLO taxonomy: Classify students' responses in solving linear program problems," *J. Phys. Conf. Ser.*, vol. 1538, no. 1, pp. 1–15, Jun. 2020, doi: 10.1088/1742-6596/1538/1/012107.
- [2] A. De la Hoz Serrano, A. Álvarez-Murillo, E. J. Fernández Torrado, M. Á. González Maestre, and L. V. Melo Niño, "A Case Study of Computational Thinking Analysis Using SOLO Taxonomy in Scientific–Mathematical Learning," *Computers*, vol. 14, no. 5, pp. 1–14, May 2025, doi: 10.3390/computers14050192.

- [3] R. Wikrama Wardana, F. A. Yanti, M. Ummas Genisa, M. Anas Thohir, E. Heryensi, and R. F. Handayani, "Mapping the Knowledge Structure of Students with Intellectual Disabilities Through SOLO Taxonomy-Based Automated Assessment," *Journal of Intellectual Disability-Diagnosis and Treatment*, vol. 14, pp. 15–27, 2026.
- [4] Q. Gao, "A Study on the Application of SOLO Taxonomy theory in Senior School English Writing Teaching from the perspective of the integration of teaching evaluation," *Education and Social Work*, vol. 1, no. 2, p. 106, Jun. 2025, doi: 10.63313/esw.9065.
- [5] A. Boikou, A. A. Economides, and S. A. Nikou, "Business simulation games: impact on SOLO taxonomy learning outcomes, learning performance and teamwork competency," *Interaction Design and Architectures Journal*, vol. 53, no. 53, pp. 161–175, 2022.
- [6] P. Yuanita, M. Maimunah, K. Kartini, and N. Arif, "Analysis of SOLO taxonomy-based test instruments in approaching the Merdeka curriculum," *Jramathedu*, vol. 8, no. 1, pp. 12–29, Jan. 2023, doi: 10.23917/jramathedu.v8i1.1270.
- [7] L. Rembach and L. Dison, "Transforming taxonomies into rubrics: Using SOLO in social science and inclusive education," *Perspectives in Education*, vol. 1, no. 43, pp. 68–83, 2016, doi: 10.18820/2519593X/pie.
- [8] S. M. Adeniji, P. Baker, and M. Schmude, "Structure of the Observed Learning Outcomes (SOLO) model: A mixed-method systematic review of research in mathematics education," *Eurasia Journal of Mathematics, Science and Technology Education*, vol. 18, no. 6, pp. 1–15, 2022, doi: 10.29333/ejmste/12087.
- [9] G. K. W. Wong, S. Jian, and H. Y. Cheung, "Engaging children in developing algorithmic thinking and debugging skills in primary schools: A mixed-methods multiple case study," *Educ. Inf. Technol. (Dordr.)*, vol. 29, no. 13, pp. 16205–16254, Sep. 2024, doi: 10.1007/s10639-024-12448-x.
- [10] P. Yuanita, M. Maimunah, K. Kartini, and N. Arif, "Analysis of SOLO taxonomy-based test instruments in approaching the Merdeka curriculum," *Jramathedu*, vol. 8, no. 1, pp. 12–29, Jan. 2023, doi: 10.23917/jramathedu.v8i1.1270.
- [11] C. M. Sudaria and J. M. P. Sanchez, "SOLO-based Formative Assessments in Teaching and Learning Earthquakes," *Science Education International*, vol. 35, no. 4, pp. 408–420, 2024, doi: 10.33828/sei.v35.i4.11.
- [12] Y. Lin, "An Analysis of the Flipped Classroom Based on the Bloom's Taxonomy of the Educational Objectives," *Advances in Social Science, Education and Humanities Research*, vol. 1, no. 615, pp. 679–685, 2021.
- [13] C. M. Sudaria and J. M. P. Sanchez, "SOLO-based Formative Assessments in Teaching and Learning Earthquakes," *Science Education International*, vol. 35, no. 4, pp. 408–420, 2024, doi: 10.33828/sei.v35.i4.11.
- [14] A. Alhammadi, I. Alsyouf, C. Semeraro, and K. Obaideen, "The role of industry 4.0 in advancing sustainability development: A focus review in the United Arab Emirates," *Clean. Eng. Technol.*, vol. 18, no. 1, Feb. 2024, doi: 10.1016/j.clet.2023.100708.