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# MAPPING DIFFICULTIES IN PROBLEM-SOLVING PROCESS DURING VIDEO-ASSISTED SELF-REGULATED LEARNING TRAINING FOR STUDENTS: INTRODUCING THE PS-SOS MAP

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## Abstract

In the ever-changing landscape of the Information Age, the development of self-regulated learning (SRL) skills has become increasingly important. Problem-solving is a critical SRL skill, and teachers play a vital role in fostering these abilities among their students. However, learners and teachers face challenges during the problem-solving process and in evaluating its incorporated strategies. To address these issues, this study explored students' difficulties in problem-solving while implementing a video assisted SRL training program. This program was developed based on an integrative framework to facilitate a structured problem-solving process in disciplinary or generic contexts. The program aimed to activate additional SRL skills, such as time management, feedback, elaboration, and critical thinking, through a digital toolkit of learning support materials. This paper focuses on 241 students' difficulties identified and classified according to the problem-solving framework that reported by teachers in different disciplines and grades (6-11). The analysis revealed that the most significant difficulties arose during the problem identification, followed by time planning and management, problem exploration, solution development, and solution evaluation. Based on this study, a dedicated map was developed called PS-SOS MAP to identify difficulties in different steps and tasks throughout the problem-solving process. The utilization of this mapping can also aid in the creation of feedback systems based on technology, such as chatbots or virtual assistants, that can provide valuable assistance to students during problem-solving training, facilitating the process of overcoming difficulties.

## Keywords:

Video-based training; Problem-solving; Problem-based learning; Self-regulated learning; K-12 education

## Introduction

Self-regulated learning (SRL) is crucial as it empowers individuals to take control of their own learning process, enabling them to learn more effectively, adapt to new situations, and achieve their goals (Alderman & MacDonald, 2015; Efklides & Metallidou, 2020; OECD, 2021). Numerous studies have emphasized the importance of fostering SRL skills during the developmental stage of young adolescence, as it plays a vital role in their lifelong learning (Alderman & MacDonald, 2015; Hanewald, 2013; Schloemer & Brenan, 2006). Video-based technology has been recommended to facilitate SRL strategies and enhance the learning process (Wang, 2011; Dresel & Haugwitz, 2008; Jansen, 2020). Despite the growing use of video for various purposes, including video conferencing and subject knowledge delivery, its primary utilization for SRL training has been limited, especially among young adolescents (Arifin et al., 2020; Dresel & Haugwitz, 2008; Cohen et al.,2022; van Alten et al., 2020).

Within the context of SRL, problem-solving is a fundamental skill that involves a multifaceted cognitive process, requiring individuals to utilize a diverse range of skills and strategies to effectively navigate and overcome challenges (Csapó & Funke, 2017; Khoiriyah & Husamah, 2018; OECD, 2021). Teachers play a critical role in promoting these abilities among their students (De Smul et al., 2019; Sulisworo et al., 2020; Uka & Uka, 2021). In addition, feedback is essential to the learning process in general, and particularly in promoting SRL skills (Cohen et al., 2022; Nicolaidou, 2013; van Ginkel et al.,2019). Through targeted feedback, learners can monitor their progress, identify areas for improvement, and adjust their strategies accordingly. Therefore, it is essential that instructional practices incorporate feedback mechanisms, especially in SRL training (Araka et al., 2020; Panadero et al., 2016; Zheng, 2016). To provide feedback on problem-solving strategies, it is crucial to define, measure, and evaluate the difficulties that related to these strategies (Yavuz et al., 2017; Liu & Israel, 2022).

Literature often highlights two primary challenges: the difficulties learners encounter during the problem-solving process; and the challenges involved in measuring the use of strategies (Liu & Israel, 2022; Tissenbaum, 2020).

In response, this study aims to identify and map the challenges that students face during problem-solving while undergoing video based SRL training. The study intends to measure and identify specific steps and tasks within the problem-solving framework where students encounter difficulties, based on teachers' perspectives. The study's contribution lies in creating a comprehensive map that facilitates the identification of challenges during the problem-solving process. This map can aid in developing SRL training programs that offer supportive feedback, be it from a human or technology-based source, thereby addressing the identified difficulties.

## The current research

### *Research objective and question*

This study focused on analyzing the responses of teachers regarding the difficulties their students encountered while working on problem-solving within a video-based training program. The aim was to gain a better understanding of the specific challenges that learners face during the problem-solving process and to identify the gaps in their SRL skill development. The analysis of teacher responses provides valuable insights into the practical application of SRL training programs in the classroom; and highlighting areas where further support may be needed to promote effective problem-solving strategies among students. Therefore, the research question is what are the difficulties students encounter when engaging in the process of problem-solving during video assisted SRL training?

### *Research context and population*

In this study, teacher and student training programs were established. The teacher training program consisted of 10 blended sessions, both face-to-face and online, and accompanied by a student intervention program. The students were exposed to a generic problem-solving framework called VAST (Video assisted SRL training) that incorporates specific SRL strategies such as time management, feedback, elaboration, and critical thinking. The VAST framework was developed based on existing literature (Davidson & Sternberg, 2003; Kim & Hannafin, 2011; Mourtos et al., 2004; Snyder, & Snyder, 2008) and presents a systematic approach to problem-solving, consisting of several distinct steps and tasks that are conveyed through a digital toolbox. The digital toolbox included interactive videos, checklists, and problem-solving tasks. The videos' content was created in alignment with the problem-solving framework's various steps and the specific tasks involved in each step. Table 1 outlines the steps and tasks of the framework.

Table 1: The developed VAST problem-solving framework.

| Learning stages | Forethought | | Performance | Reflection |
|---|---|---|---|---|
| **SRL strategies related to time** | **(S1) Time planning** | | **(S4) Time management** | **(S7) Time management evaluation** |
| | (T1.1) Define deadline for final solution.<br>(T1.2) Define steps deadlines.<br>(T1.3) Assess schedule feasibility.<br>(T1.4) Use an assistive tool to document the planned schedule. | | (T4.1) Monitor planned schedule.<br>(T4.2) Detect time deviations.<br>(T4.3) Reschedule deadlines.<br>(T4.4) Assess reschedule feasibility. | (T7.1) Detect time deviations.<br>(T7.2) Define reasons for time deviations.<br>(T7.3) Use time deviations reasoning to explore alternatives for future problems. |
| **Problem-solving strategies integrating other SRL strategies (critical thinking, elaboration, and feedback)** | **(S2) Problem identification** | **(S3) Problem exploration** | **(S5) Solution development** | **(S6) Solution evaluation** |
| | (T2.1) Define the problem in your own words to ensure under-standing.<br>(T2.2) Determine the rules and constraints.<br>(T2.3) Define criterion for judging solution.<br>(T2.4) Break the problem down into smaller questions.<br>(T2.5) Reflect on the activity in this step. | (T3.1) Identify related topics based on prior knowledge.<br>(T3.2) Determine the given/known information that might assist in solving the problem.<br>(T3.3) Identify and complete information gap necessary for moving forward with the solution.<br>(T3.4) Pose operational questions concerning the problem.<br>(T3.5) Reflect on the activity in this step. | (T5.1) Identify candidate solutions.<br>(T5.2) Analyze candidate solutions - using constraints and criteria.<br>(T5.3) Investigate needed information for each solution.<br>(T5.4) Choose the best solution according to the criteria.<br>(T5.5) Implement a detailed work plan.<br>(T5.6) Reflect on the activity in this step. | (T6.1) Present and communicate the solution (when relevant)<br>(T6.2) Justify/ defend/ Update the solution.<br>(T6.3) Monitor the problem-solving process.<br>(T6.4) Improve the problem-solving process.<br>(T6.5) Reflect on the activity in this step. |

(S#): Chronological step number; (T#): Chronological task number.

During the intervention program, students worked in groups to solve a problem using the framework's process, while their teachers provided feedback on the difficulties they faced. The study involved 11 teachers who represented a range of disciplines and implemented the video-based training program for a total of 269 students in grades 6-11. To gather data, teachers completed two questionnaires: one describing classroom situations where difficulties arose, and another outlining successful practices for addressing difficulties.

### *Research method and procedure*

This paper presents primary findings on student difficulties reported by their teachers, using both qualitative and quantitative methods with a focus on the latter. The teachers' responses were initially analyzed qualitatively to identify difficulties faced by students in the classroom. The research team filtered these difficulties according to the problem-solving framework and categorized them based on the specific tasks where the difficulties arose.

This filtering process was independently conducted by two experts in the SRL field who developed the problem-solving framework. The filtered results were then consolidated and compared. The number of occurrences of each difficulty was calculated for each task within each step of the framework. Quartiles were calculated to compare the occurrences of difficulties across tasks, providing insight into which tasks posed more challenges. Data analysis was conducted using JASP 17.01 software.

## Findings

A total of 40 responses were provided by teachers, yielding various difficulties (N=241) that were categorized according to the different steps and tasks within the problem-solving framework. Notably, certain difficulties pertaining to issues such as motivation, emotions, and technology, were not clearly associated with any specific task or steps and tasks in the framework. Thus, these difficulties were excluded from the analysis.

In order to compare the frequency of difficulties reported by teachers in different tasks at various steps, a quartile calculation was conducted. The aim was to identify the tasks where students encountered more difficulties. The results of the analysis are presented in Table 2.

Table 2: Quartile calculation of difficulties in 32 problem-solving tasks within the VAST framework

|  | Valid | Missing | Mean | Std. Deviation | Minimum | Maximum | 25th percentile | 50th percentile | 75th percentile |
|---|---|---|---|---|---|---|---|---|---|
| Students' difficulties | 32 | 0 | 7.531 | 4.501 | 1.000 | 17.000 | 4.000 | 7.000 | 9.000 |

According to the analysis, the highest number of difficulties was classified as part of the *problem identification* step: problem definition (n=17), constraints identification (n=17), solution criteria definition (n=17), questioning (n=17), as well as reflection (n=12). In addition, a high number of student difficulties were classified in the *time planning* (n=9) and *time management* (n=9) steps. For the *time management evaluation* step, only a limited number of difficulties were classified in each task (n=4). Moreover, a significant number of difficulties were classified in the reflection task of the *problem identification* (n=16), *problem exploration* (n=15), and *solution development* (n=14) steps, compared to other tasks within each step. Furthermore, in the *solution evaluation* step, the task of presenting and communicating solutions to peers was found to be particularly challenging for students compared to other tasks in this step (n=8).

The difficulties that students faced during problem-solving, as identified by their teachers, were compared across different tasks within the framework and visualized as the PS-SOS map using the previously mentioned calculation. This map provides an overview of the specific tasks and steps within the problem-solving framework where students encountered difficulties. Each quartile represents the difficulty level of a particular task, with the color scale representing the amount of difficulty levels associated with each task. Red represents a high number of difficulties, and green represents relatively few. The PS-SOS Map, which visualizes the difficulties reported by the teachers, is presented in Figure 1.
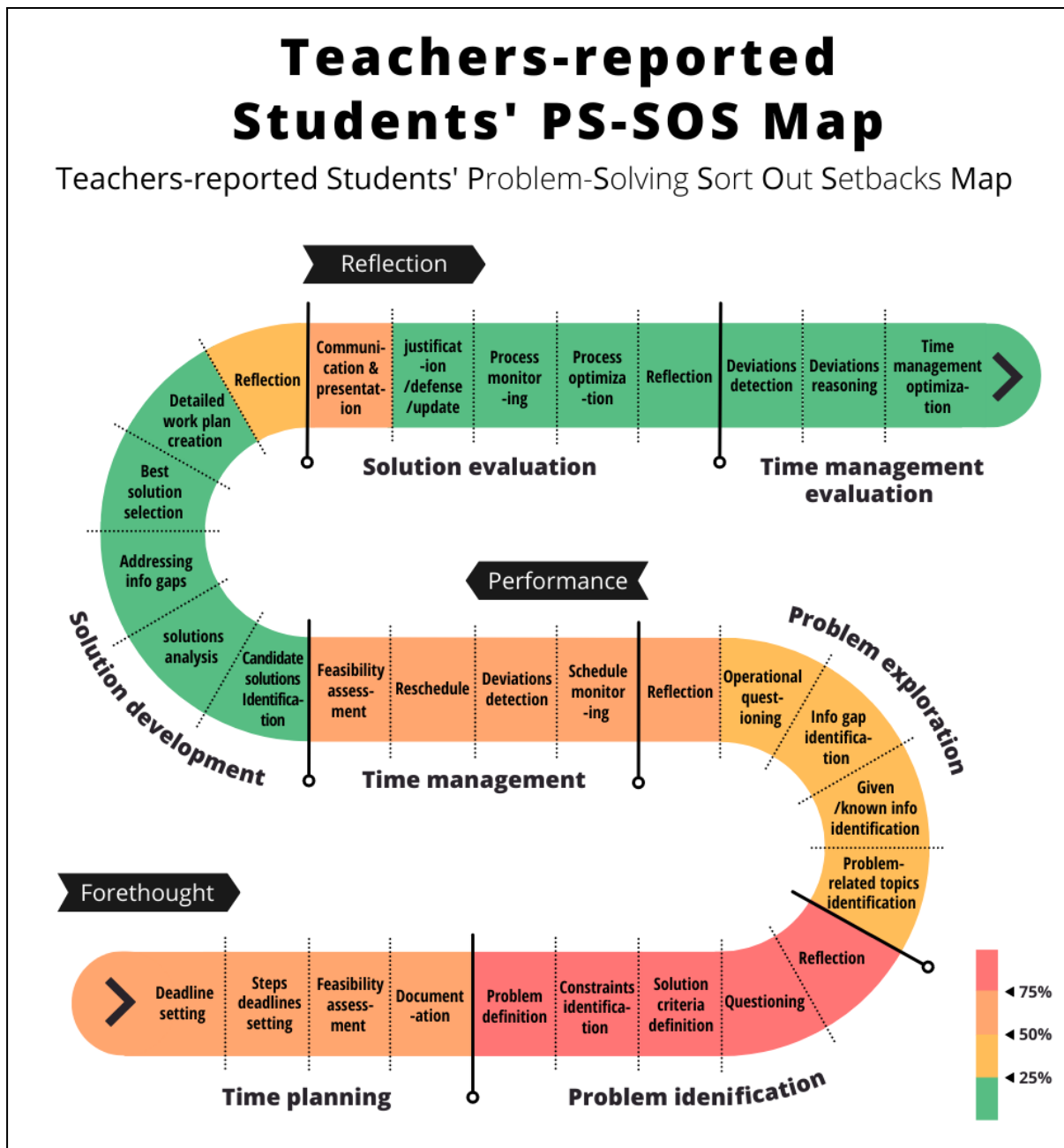
Figure 1. Teachers-reported Students' PS-SOS Map: The relative share of students' difficulties in each task of the problem-solving framework. For example, the number of difficulties in the task 'Deadline setting' (indicated by the orange color) is higher than 50% of the other tasks.

## Discussion and conclusion

Measuring SRL strategies and identifying students' difficulties during problem-solving can be complex tasks (Liu & Israel, 2022; Tissenbaum, 2020). The present study addresses these research gaps by classifying the difficulties students experience during problem-solving based on the specific steps and tasks where they face relatively higher levels of difficulty compared to others. The resulting PS-SOS map can facilitate the creation of support mechanisms for students during their independent problem-solving process, providing accurate scaffolding in real-time.

Specifically, the study found that students struggled the most with problem identification, which may have had a cascading effect on their ability to evaluate solutions. Additionally, students encountered difficulties with planning

and time management. These SRL skills are crucial for successful problem-solving (Davidson & Sternberg, 2003; Kim & Hannafin, 2011; Mourtos et al., 2004; Snyder, & Snyder, 2008). These findings emphasize the need for additional support in these areas during SRL training.

Feedback is essential for learning, as it provides students with evaluations of their knowledge and skills, as well as suggestions for improvement (Cohen et al., 2019). However, in this study, students encountered significant challenges when presenting solutions to their classmates for feedback during the solution evaluation step. The difficulties could stem from collaborative work issues, lack of confidence, and unfamiliarity with evaluation and reflection strategies. The high level of reported difficulties in the reflection task throughout the various steps supports this conclusion. These findings highlight the importance of providing students with support in developing effective communication skills related to feedback, particularly in group settings (Nicolaidou, 2013; van Ginkel et al.,2019).

It's worth noting that the problem-solving framework and video-based training were introduced to both teachers and students for the first time. This emphasizes the need for further implementation and investigation. In addition, difficulties related to motivation, emotions, and technology were difficult to link to specific steps or tasks. Hence, additional research is necessary to identify motivational and emotional strategies that could enhance the mapping framework and collect data on task-level difficulties. Furthermore, the data on student difficulties are based solely on teacher self-reports, which may not accurately capture individual differences among students. To address this issue, it's crucial to gather feedback from students during the process and use a more personalized approach in dealing with student difficulties.

In summary, addressing the difficulties that students face during problem-solving tasks is crucial for promoting effective learning and SRL skills. Teachers play a critical role in gaining valuable insights and using this information to train their students. The developed problem-solving framework and the PS-SOS map can aid in identifying problematic steps and tasks. To improve problem-solving skills, future training programs should prioritize addressing these difficulties. Additionally, research should explore the potential of difficulty-based feedback provided by teachers or technology, such as chatbots or virtual assistants, to facilitate the learning process for students.

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