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Communication

Coordinated SSM: An Adaptation of the SSM Learning Cycle

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Abstract: This paper discusses the coordinated use of the Soft Systems Methodology (SSM) learning cycle with additional bodies of knowledge. This approach furthers focused understanding and appreciation for taking action within social systems. Adapting the SSM learning cycle extends the richness of the real-world situation understood from an analytic soft systems perspective to encompass the appreciation of a problematical situation using additional bodies of knowledge to explain and explore. Examples illustrate using SSM to foster learning and improve teaching in a research education practice, in a national level research project and, further, in professional in-service at advanced level education.

Keywords: soft systems thinking; soft systems methodology; SSM learning cycle; higher education; research; coordinated SSM; didactical transposition; praxeologies

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1. Introduction

Viewing the world around us and thinking about it in terms of systems has a long tradition, and can be described in different ways. Donella Meadows [1] explains a system as an interconnected set of elements that is coherently organized in a way to achieve a purpose. Peter Checkland [2] defines Systems Thinking as understanding the complexity of the world, and focusing on the situation and resolutions for improvement, rather than the problems and solutions. Systems Thinking recognizes that complex situations, i.e., the real world, involve interrelated factors that emerge when multiple humans with different interests are included as objects of study [3]. Cabrera states that how the world is and how humans think of the world is a mismatch: "Wicked problems result from the mismatch between how real-world systems work, and how we think they work" [4]. He argues that the real world is complex and random, adaptive and organic, multivalent, agnostic, and non-linear. However, humans tend to think of the world as linear, casual, and mechanical, and tend to think there is an order to things. Thus, to see beyond this, to look deeper and to uncover patterns, system structures, and mental models, i.e., to see the complex reality of the natural real world, we require Systems Thinking (e.g., [4]). In addition, Gharajedaghi [5] advocates a paradigm shift from analytical to holistic thinking. He states "We see the world as increasingly more complex and chaotic as we use inadequate concepts to explain it. When we understand something, we no longer see it as chaotic or complex" [5] (p. 24). Further, he argues that a holistic language, a language of systems, will allow us to see though chaos and understand complexity.

While there are several schools of thoughts and different branches (e.g., [3,6]) within Systems Thinking, we focus in this paper on Soft Systems Thinking, which conceptualizes the world as complex and messy. In addition, this approach focuses on situations that people, for varying reasons, find problematic [7]. Checkland has identified one of the core pillar of Soft Systems Thinking as Human Activity Systems, described as "innumerable

sets of human activities more or less consciously ordered in a whole as a result of some underlying purpose or mission" [2] (p. 111). Human activity systems represent the viewpoint of humans as observers of the real world. This conception recognizes that their points of view depend upon the vantage point from which observations are made. Further, Checkland notes that social systems, in everyday language, offer the context within which the real world is observed. Social systems thereby offer situated context in which humans conduct purposeful activities, and exercise complex relationships within, for instance, communities [2,7] comprised of families, political parties, industrial firms, or schools. This is akin to the natural physical living systems that animate the universe.

The notion of Worldview, or Weltanschauung [8], is another fundamental core aspect of Soft Systems Thinking. Churchman's original use of Weltanschauung was to express "a perception of what reality is" [9] (p. 499). Mingers [10], referring to Checkland's work, describes the notion of worldview as capturing humans' experience of the world in terms of purpose, knowledge, values, expectations, etc., which are developed in various ways, including previous experiences. Although humans may have much in common with others, how they experience the world is significantly different and often contradictory, although equally valid.

To handle the complexity of the real world, bringing together human activity systems and social systems, and including varying worldviews, Checkland and colleagues developed the Soft Systems Methodology [2]. SSM is, by Checkland and other scholars such as Jackson [11], Rose [12], and Warren et al. [13], defined as a set of principles using methods for unstructured and ill-defined problematic situations. Building on this, Reynold and Holwell [3] (p. 20) present SSM as an "analysis of complex situations where there are divergent views about the definition of the problem". In this paper, the definition provided by Checkland [2] and Reynolds and Holwell [3] is adopted.

Here, we present an adapted use of the SSM learning cycle based on various efforts applying SSM. The focus is on presenting the adopted approach, including the argument and motivation behind it. The next subsection presents a brief overview of the SSM learning cycle, which this paper builds upon. The section thereafter presents the efforts using SSM and its techniques in coordination with additional bodies of knowledge. Next, the Coordinated SSM approach is presented. The paper is finalized by concluding remarks discussing the coordinated SSM approach.

2. The SSM Learning Cycle

During the evolution of Soft Systems Thinking, the Soft Systems Methodology (SSM) has been represented by Checkland in varying ways [9,14]. The current, and most frequent representation consists of four phases, the SSM learning cycle, as illustrated in Figure 1.

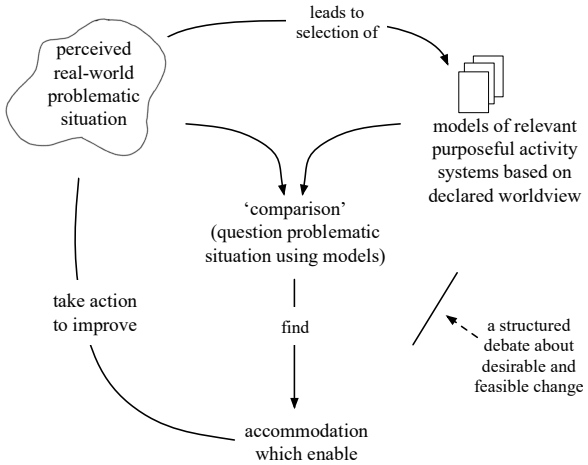

Figure 1. SSM's learning cycle (adapted from [7]).

The four phases of the SSM learning cycle consist of: (1) finding out about the perceived real world problematic situation; (2) creating models of relevant purposeful activity models based on declared worldviews; (3) questioning the problematic situation and using the constructed models, with the aim to identify desirable and feasible changes; and (4) taking action to improve [15]. The learning cycle includes iterations whereby the final phase, taking action to improve the initial situation, will lead to a new situation and, hence, the potential need for the process to restart [7]. In addition, a number of models within SSM are used for the understanding of the problematic situation, such as the Rich Picture technique, PQR (what, how, and why), CATWOE (Customer, Actor, Transformation, Worldview, Owner, and Environment), and Purposeful Activity Models [15]. These modeling techniques will, however, not be further elaborated in this paper, as we propose an alternative application/approach of the learning cycle.

Rather, in this paper, the notion of SSM's learning cycle within Soft Systems Methodology is used, as it allows a structured use of methods for capturing, illustrating, and discussing complex and messy situations, taking varying worldviews and perspectives into account. In the upcoming section, we present our use of the SSM learning cycle in research and education.

3. Using the SSM Learning Cycle for Knowledge Building in Research and Education

This section presents varying efforts using the SSM learning cycle in varying settings which have contributed to the approach presented in the subsequent section.

Salavati [16] applied Soft Systems Methodology (SSM) techniques to illuminate and enhance understanding of the complex everyday practice of school teachers in relation to their use of digital technologies. SSM provided a clear structure and methods to appreciate the complex problematical situation and rich empirical data, including different perspectives and worldviews. However, in addition to the techniques provided by Checkland as part of SSM [15], cognitive maps [17] were also used as a bridge from describing the situation to initiating the modelling [16,18]. Figure 2 illustrates the work process building on the SSM learning cycle.

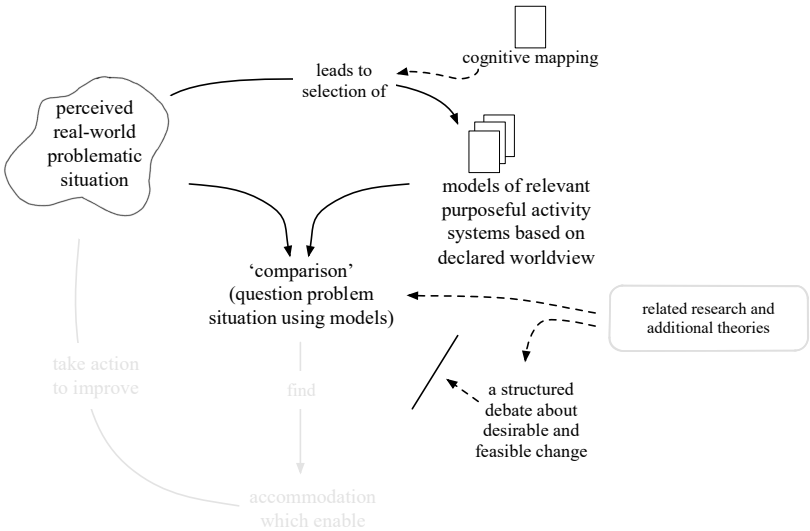

Figure 2. Work process of applying SSM.

Although the Soft Systems Methodology includes several modelling tools, additional tools were required in the research project for exploring, explaining, and thereby gaining deeper understanding of underlying structures and nuanced context. Additional models and theories (e.g., TPACK by Mishra and Kohler [19]) and related research (e.g., Philosophy of Teaching [20]) supported more granular and more holistic discussion of the SSM analysis, i.e., the real world situation. The research contributed to the Technology Enhanced Learning

application area through increased understanding of the complexity of teachers' everyday practice using digital technologies. Project outcomes also contributed to the literature on SSM as a research methodology, specifically its potential use with additional bodies of knowledge.

In parallel, a semester long masters-level course in digital business transformation was delivered by the Department of Informatics at Linnaeus University, Sweden. The course, consisting of 26 students working as professionals in different industries, included two parts: the first addressed the specific topic of the course with relevant literature, and the second part addressed Systems Thinking, primarily focused on SSM but also including the Viable Systems Model (VSM) [21]. Several of the students applied the models and theories from the digital business literature to their SSM modelling, allowing them to elaborate and more robustly present their insights. In addition, several students noted the benefits of VSM for their application area, and therefore included the VSM model in their project work. The students considered the coordination of other theories with SSM as adding valuable dimensions to the project work as it allowed them to appreciate and understand the context, perspectives, and relations, i.e., the overall complexity. This was expressed by some students in the course evaluation, as for example (The statements are translated from Swedish to English by the authors of the paper.):

> "*The different methods and approaches, that I can use them in my organization to illuminate different problematic situations.*"
>
> "*It was very interesting working with VSM (it is was difficult) and the case example, and I like different 'tools' that work together, and that I with their help can diagnose different problems.*"

In addition, similar approaches have been applied in international education and research projects, which further illustrated the benefit of coordinating SSM with additional bodies of knowledge [22–25].

Continuing the abovementioned approach, and taking inspiration from the students' work described above, the application of SSM has been further elaborated and applied in one ongoing research project and two additional higher education courses. The research project, Maker Tour—Mot Nya Höjder (in English, Maker tour—Reaching for the stars), is a national school project in parts of Sweden where the aim is to increase interest in STEM subjects, i.e., natural science, technology, engineering, and mathematics, among young people in grades 1 to 8 [26]. The ongoing research focuses on two aspects of the project, as identified by the researchers: the organizational aspect and the didactical system. The organizational aspect is mainly analyzed using Soft Systems methods and techniques, and the didactical system is examined by using the theory of didactical transposition of knowledge and, in particular, the notion of praxeologies. The two latter theories are didactical theories that can be used to focus on various aspects of knowledge transformation in institutions such as schools [27]. As the project includes different actors from different organizations across the country, SSM and a few of its modeling techniques enabled us to taking into account the actors and the relationships between them. SSM further contributed to addressing the complexity in a structured way, while maintaining different perspectives and worldviews and the complexity of the school education context. The didactical transposition and praxeology have been used to analyze some epistemological aspects of the material developed by the project team and used by the teachers in the classrooms [28]. This analysis showed the epistemological and didactical strengths and weaknesses of the material, and enabled a discussion on the future work and development of future material. In the upcoming research work, we will use the adapted approach of SSM, presented in this paper, to connect the didactical analysis and the organizational analysis with the aim to expand the understanding of the project overall. Further, we aim to include related research to broaden the analysis in order to suggest additional improvements or ideas for potential development of the project. This approach allows us to capture the complexity and colliding perspectives of the actors in the real world context

of the project, and explain it using knowledge and expertise related to transposition of knowledge relevant to the aim of the project.

This approach has also been applied in two newly developed courses at Linnaeus university, Sweden. Both courses have similar course design, but have different professional contexts. One course targeted to in-service primary school teachers and focused on the use of digital technologies. This course consisted of five students and was given as a semester long course. The second semester long course consisted of 33 students in an advanced level course within eHealth, targeting health professionals. While the course design has its basis in the SSM learning cycle, it has been enhanced, similar to the abovementioned research project, to include additional bodies of knowledge in order to enhance students' understanding of the situation, including underlying structures of and different perspectives in their work practice. The course design for professional schoolteachers included three parts, each assessed with an individual assignment. The assignments included: (1) a theoretical part where the students describe the relationship between design, technology, and learning, using course literature and related research, (2) a Systems Thinking component which explicates the complexity of the school through creation of an SSM Rich Picture of their profession or a specific situation, and (3) project work where the students focus on a specific part of their SSM Rich Picture by making models using PQR [15] or RPQ [18], and relate the models to their reasoning in the first theoretical assignment. As the first assignment only advances theoretical understanding, students needed an approach and tools to gain a more encompassing overview and higher appreciation of the real world practice, as well as a deeper understanding of the different parts and their relationships. The Rich Picture in the second assignment cultivates in students a more comprehensive image of the situation, capturing the complexity of the educational context, the digitalization and different actors, different perspectives, and their relationships. In the third assignment, the students continue with the SSM modeling, applying their theoretical lens to the outcome of the SSM analysis and its contextual focus. When the students use the theoretical understanding gained from the first assignment to discuss a specific part of their Rich Picture, modeled and analyzed using PQR/RPQ, they were able to widen their understanding and explain their findings and insights from their own real world practice and perspective.

The second course for healthcare professionals had the same course design as the school teachers'. The course design is illustrated in the figure below.

The students were asked in their first assignment to draw a Rich Picture of a specific work situation or their profession in relation to IT/information systems within a health context (see top left corner of Figure 3). This allowed the students to capture the complexity of their profession and work practice related to digital technologies. In their second assignment, the students were asked to focus on one part where they see potential for improvement and create a number of PQR/RPQ models, in which they argue for these potential improvements using the course literature (illustrated in middle and right central part of Figure 3). Again, at this point, the students were enabled to deepen their insight using course literature and related research to understand the complex real world, the perspectives, and underlying parts that they illustrated in their Rich Picture. In this course, we also asked the students to draw a new Rich Picture illustrating the outcome of their discussion and results of the models and analysis (see lower middle part of Figure 3). Using SSM, the students could structure the complexity and richness of their practice when adding additional theory and knowledge. In both of the courses, the final step, the carry out or take action (illustrated in grey in Figure 3), was not applied. The evaluations for these courses mainly focused on course design, such as literature, the assignments, the learning platform, and the accessibility of the teachers, rather than outcome and learning. However, students have later contacted us telling they have used the approach they learnt in their everyday work practice.

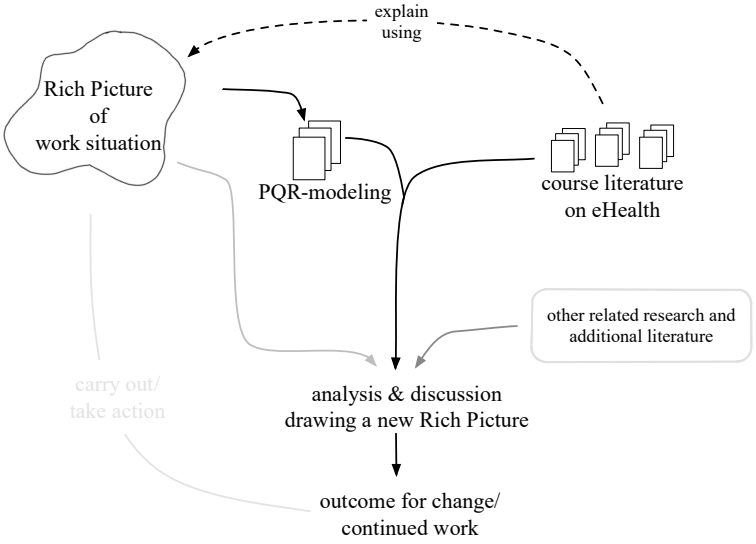

Figure 3. Course design applying alternative approach to SSM.

The upcoming section presents the outcome of the experiences gained using SSM, together with additional bodies of knowledge that we believe may be used to catalyze and amplify learning in educational settings and in research context.

4. Presenting the Coordinated SSM Approach

As described in the examples above, applying Soft Systems Methodology and coordinating it with additional bodies of knowledge gives opportunities to enhance exploration and understanding, as well as the analysis and discussions of the situation of focus. SSM and its learning cycle provides a solid structure and process. To this, we added additional knowledge to the original model. Figure 4. below illustrates this coordinated adaptation.

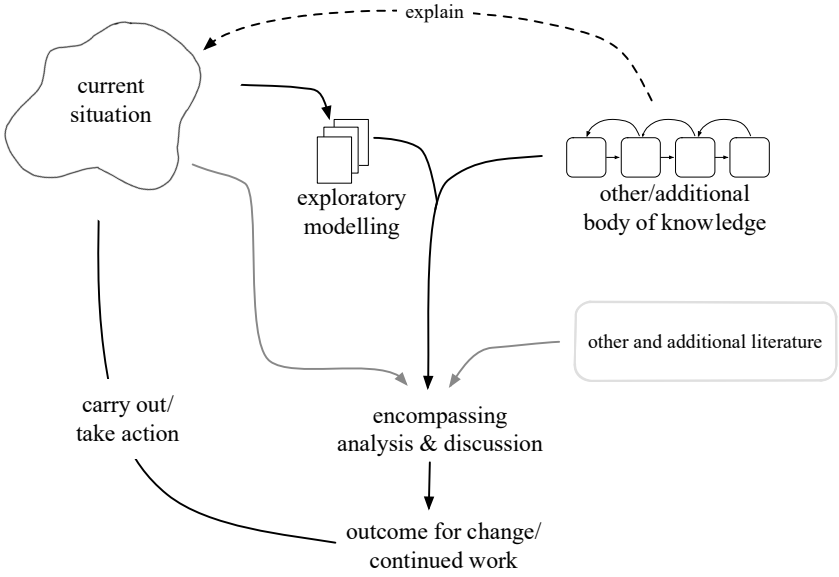

Figure 4. Coordinated SSM.

The Coordinated SSM approach builds upon the SSM learning cycle (see Figure 1) and is also iterative. The approach consists of four phases: (1) description of the current situation, (2) exploratory modelling and inclusion of additional body of knowledge, (3) encompassing analysis and discussion for change and continued work, and (4) carry out and take action, which are elaborated below.

The first phase, description of the current situation (illustrated in the top left corner), aims to describe and illustrate the situation in focus. By using, preferably, SSMs' Rich Picture technique [15], it is possible to capture and create an understanding of the current situation. The Rich Picture is created based on empirical material from the real world setting with the aim to illustrate a comprehensive overview of the current situation. The Rich Picture enables illustration of the complexity of the situation, including the varying levels of the context, the different actors' worldviews and perspectives, power relations, conflicts, and uncertainties. It will, hence, provide a comprehensive yet detailed understanding of the situation. The Rich Picture also needed to be described and explained in text, and this can either be achieved based on what emerged from the empirical material, or it can be explained using a different/other body of knowledge as a context boundary. The latter gives a contextual frame for what could be relevant to illuminate, based on the focused situation and the aim of applying SSM (i.e., the digitalization context of schools or health care in the examples above).

The second phase, exploratory modeling and analysis, consists of developing models and exploring the situation based on the Rich Picture and the description of the situation in focus, i.e., the empirical material. If additional bodies of knowledge have been used to describe the current situation, this can enable a simpler way to find relevant systems to model (as done by Salavati [16]). The modeling of the situation in focus can be conducted with methods such as Cognitive Maps [17,29], PQR [15], or RPQ- modelling [16,18], just to name a few. Additional models from SSM and/or other Soft Systems approaches and traditions can be used. Further, in this phase, additional bodies of knowledge are included as a frame of analysis. The bodies of knowledge provide a perspective through which the situation is analyzed, described, and/or discussed based on the outcome of the first phase.

In the third phase, encompassing analysis and discussion, the models and initial analysis from the second phase are brought together to a more overarching analysis and discussion, further elaborating the outcome of the modeling based on the bodies of knowledge. The analysis and discussion can be structured as themes identified from the Rich Picture (as done by Salavati [16]) or could be based on, for example, categories from the knowledge foundation. As part of this phase, it is also possible to include prior and similar research on the subject/problem/issue in focus (illustrated as a grey box in the middle right part of Figure 4). Adding prior and similar research can add further dimensions to the outcome of the analysis and discussion and, hence, widen the understanding and appreciation of the situation, perspectives, relations, and underlying structures.

As a final phase, carry out and take action, the analysis and discussion lead to some sort of action for change or indication for further effort. The outcome can thereafter be applied and carried out on the current situation to achieve feasible and desirable change. If relevant, the cycle can be carried out once again, based on the new current situation with the same aim and ambition, or with a shift in focus to further develop, change, and improve the situation in focus.

5. Concluding Remarks

In a postscript in the latest edition of Checkland and Poulter [15], Scholes et al., reflect on the 50-year history of SSM. SSM has been applied to various fields and is well known within the research disciplines. In an article by Warren et al., the authors illustrate the wide establishment of SSM and its high impact in academia [13]. Scholes et al. (in [15]) reflect on the strength of SSM, especially the clarity of the model and its ability for adoption for professional practices. Our understanding is that many authors share this view, including us.

SSM is an established methodology that provides structure and process to address complex situations which are often characterized by uncertainties, power relations, multiple worldviews, and different perspectives. It supports and enables the capture, illustration, and illumination of the complexity of chosen situations within the real world, making exploration, description, and analysis processes structured and graspable. Our point

of departure as higher educators and researchers is to advance students' and project participants' capabilities to appreciate a world that is complex and messy, that consists of humans with their specific worldviews, mental models, and points of view, which affect activities aimed to achieve some relevant purpose. Therefore, Systems Thinking, and in particular Soft Systems Thinking is needed to learn ways to tackle messy and complex situations. In our research, we have identified a need to coordinate the SSM learning cycle. The adaptions suggested in this paper preserve the strengths of SSM, which fosters seeing the world through the eyes of another. This includes understanding and illuminating complexity, i.e., exploration, description, and understanding of the variation in humans without seeking to provide the final answer and correct solution. In addition, our proposed coordinated SSM provides both focus and boundary using and applying the strengths of other bodies knowledge, without losing the richness of the complex real world created through SSM theories and tools. By coordinating the SSM learning cycle with additional bodies of knowledge, we argue it is possible to advance understanding of problematical situations and contributing factors. The coordinated approach enables the bridging of the richness of the complex real world situation, captured and structured by SSM, together with the perspectives of specific bodies of knowledge. For example, we can use linear and casual thinking embodied in theories and models to understand parts of a non-linear world without diminishing the random, complex, adaptive and organic, multivalent, and agnostic reality of the real world (i.e., applying Systems Thinking).

This paper presents an adapted use of the SSM learning cycle coordinated with additional bodies of knowledge as a modified analytical approach. Coordinating the SSM learning cycle with additional components can simplify the passage from description of the current situation (phase 1) to the modelling phase (phase 2), as it aids finding relevant systems to model. Further, addition to the learning cycle enriches the modeling carried out as part of the SSM analysis phase, to produce a more holistic analysis and discussion from a theoretical perspective or context relevant for particular application aims, rather than only from SSM's cultural feasible and systemic desirable perspectives (phase 3).

The current efforts applying this approach have, to date, not reached the final phase (phase 4) of taking action or identifying and suggesting efforts for future work. This is the next step in the ongoing research project Maker Tour—Mot Nya Höjder. In addition, research and courses will also continue to be elaborated and developed to provide the students with approaches and tools to better structure and handle complex situations and everyday work practices. We do not make empirical claims about the efficacy of our approach, as it has not yet been formally validated. Future efforts will also include evaluation and validation of the Coordinated SSM approach by a structured survey and interviews among the participant students and project members.

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