

THE EFFECTIVENESS OF SYSTEM THINKING ANALYSIS
USING ARCHIMATE IN THE FIELD OF EDUCATION:
A CASE STUDY OF THE HOME EDUCATION SYSTEM
IN BRITISH COLUMBIA, CANADA

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Can ArchiMate, the most expressive business model notation, be used to analyze cases in education?

- This study examines the home education system in British Columbia, Canada, utilizing ArchiMate, and brings a new level of clarity to its characteristics and issues.
- The authors used the EA modelling language ArchiMate to represent each educational system using the CATWOE analysis.
- By visualizing the similarities between homeschooling and K-12 Online Learning in a concise diagram using ArchiMate, the authors identified their commonalities and pointed out that they could be integrated.
- In addition, by extracting the general education functions of owners, teachers, students, and worldviews using ArchiMate, the authors could identify issues that had not always been clear.
- This analysis not only identified these issues but also brought a new level of clarity to the understanding of educational systems, particularly in the context of conflicts between worldviews in education and the conflicting principles of conduct that students and teachers must follow due to these conflicts.

Presentation Outline

1. Introduction
2. Related Work
3. Methodology
4. Results
5. Discussion
6. Conclusion

1. INTRODUCTION

- For a long time, Pedagogy was understood as a system of reflection within the education system that applied the theories produced by science to practice.
- According to Niklas Luhman's theory of social systems, the scientific system and the educational system belong to different functional systems, each with its unique history, and it is challenging to assume a simple relationship where the former's theory is applied to the latter (Suzuki, 2022, p.258) ^[1].
- In this study, we will adopt a unique perspective using a system thinking analysis based on ArchiMate, the EA modelling language standardized by The Open Group.
- This approach will allow us to express the complex and intertwined structure of the home education system in British Columbia (hereafter, BC), Canada, from multiple perspectives, making it easier to understand and organize, and showing its characteristics in a novel light.

2. RELATED WORK

2.1. Home education system in British Columbia

Homeschooling (HS)

- is outside the framework of public education
- offers parents the flexibility

K-12 Online Learning (OL)

- was established to provide public education to students living in remote areas
- offers a structured curriculum and distance support

The two systems are entirely different but similar in that they both focus on learning in the home. There is confusion, such as the fact that even families enrolled in OL consider their children to be homeschoolers (BC Homeschooling Manual Procedures & Guidelines, 2024, p.6) ^[2].

2.2. Differences between homeschooling and online learning

Table 1. Differences between homeschooling, online learning and in person learning.

TABLE 1 – Differences between homeschooling, online learning and in person learning			
CRITERIA	HOMESCHOOLING	ONLINE LEARNING THROUGH B.C. PUBLIC OR INDEPENDENT SCHOOL	IN-PERSON LEARNING THROUGH B.C. PUBLIC OR INDEPENDENT SCHOOL
Must follow the B.C. Curriculum	No	Yes	Yes
Learning must be supervised by a B.C.-certified Teacher, as part of their duties of employment with a B.C. school (responsibilities include planning, selecting Educational Resource Materials, facilitating learning activities and documenting learning)	No	Yes	Yes
Learner progress must be evaluated, and report cards prepared by a B.C. certified Teacher	No	Yes	Yes
Learner must participate in Provincial Graduation Assessments and Foundation Skills Assessments	No (FSA & Grad Assessments are optional)	Yes	Yes
Religious beliefs may be taught	Yes	No - in public	No - in public
		Yes - in independent	Yes - in independent
“Status” in a school	Registered Homeschooler*	Enrolled Student	Enrolled Student
* Registered Homeschoolers who are eligible to enroll in Grades 10-12 courses may remain a homeschooler while also enrolling in Online Learning courses at the Grade 10 to 12 level.			

2.3. Cases where dual enrolment for HS and OL is permitted

Table 2. Online Learning enrolment options by grade level.

Grades	Full-time Enrolment	Is Dual Enrolment allowed?	Is Cross Enrolment allowed with a POLS?	Could Students take a course with local DOLS?
GK-7	DOLS	×	×	-----
GK-7	In-Person	×	×	×
GK-7	POLS	×	×	×
G8-9	DOLS	× (local arrangement can be made)	○	-----
G8-9	In-Person	△(G10 courses only)	○	○
G8-9	POLS	△(G10 courses only)	○	△(G10 courses only)
G10-12	DOLS	○	○	-----
G10-12	In-Person	○	○	○
G10-12	POLS	○	○	○

※DOLS: District Online Learning School, POLS: Provincial Online Learning School

2.4. Systems Theory

- Rittel and Webber ^[5] categorize problems into three types: simple, complex, and wicked.
 - simple problems: straightforward
 - complex problems: difficult to define and require an iterative, trial-and-error process for their resolution
 - wicked problems: deeply embed in a social context, evolve during their definition and are notoriously hard to define



A systematic, step-by-step approach is necessary for their resolution.

- System theory posits that the current as-is and future to-be situations can be transformed into the desired future.
- The effectiveness of this transformation is evaluated by the gap between the future-to-be situation and the transformation result.
- **The system theoretic approach, with its feedback process, is particularly effective in addressing wicked problems.**

- Checkland ^[6] proposed Soft Systems Methodology (SSM)
Soft Systems Methodology
 - an integrated Systems Thinking approach to wicked social problems
 - includes a root definition and CATWOE analysis.

Root definition

- a simple sentence representing the purpose of the system to be realized

CATWOE

- means Customer (C), Actor (A), Transformation (T), World view (W), Owner (O), and Environment (E).
- helps define root definition.

2.5 Innovation and Problem Solving

- Innovation requires repeated hypothesis testing processes because the desired service and product are unknown from the start.
- Innovations are wicked problems because problems and solutions are unknown.
- Only after the innovation has occurred can we realize what innovation solved the problem.

2.6 ArchiMate

ArchiMate

- a standardized Enterprise Architecture (EA) modelling language by The Open Group ^[7]
- plays a crucial role in describing the deliverables of all processes of TOGAF (The Open Group Architecture Framework) ^[8]

EA uses System Theory

- The EA method is an iterative process that develops the future-to-be EA based on the as-is EA and then evaluates its effectiveness.
- This iterative nature ensures that the to-be EA achieves the expected performance, engaging you in the continuous improvement of EA.

ArchiMate stands out with its high expressiveness in business model notations. This should instill confidence in its ability to effectively model complex business structures.

- ArchiMate provides modelling icons of those three architecture layers.
 - Constituents of business architecture: actors, business processes and business goals
 - Application architecture: information services and objects
 - Technology architecture: computer devices and communication networks

3. METHODOLOGY

We will analyze the education system as a socio-technical system (STS).

- First, we will compare and analyze HS and OL using the CATWOE analysis used in systems thinking analysis.
- Next, we will compare and analyze HS and OL using ArchiMate's motivation analysis.
- Then, we will present our discussion.
- Finally, we will present our summary and future issues.

4 RESULTS

4.1 CATWOE Analysis

- CATWOE is used in the Soft System Methodology (SSM). The system overview can be grasped by Customer (C), Actor (A), Transformation (T), World view (W), Owner (O), and Environment (E).
- First, the CATWOE of a general education system can be organized as shown in Table 3.

Table 3. CATWOE for Education Systems.

C	Students receiving education
A	Teachers providing education
T	Educational function that transforms the state of students who do not know into the state of having acquired knowledge
W	World view
O	Owner of the education system
E	Social-technical environment

Created by the author

Next, the results of comparing HS and OL using CATWOE are shown in Table 4.

Table 4. Comparison of HS and OL using CATWOE.

	HS	OL
C	Students receiving education	Students receiving education
A	Parents, Family	Teachers employed by state or local government
T	Education closed within family	Distance education within state or local government
W	Education based on family values is necessary	Equal provision of public education is necessary
O	Family	State or local government
E	Social technology environment closed off within the family	Open social technology environment

Created by the author

It should be noted here that the students who receive education are the same in both the HS and OL. Therefore, students who are beneficiaries of the two education systems have the potential to enjoy both.

4.2 Comparison using ArchiMate

Table 5 shows that CATWOE can be expressed using ArchiMate elements.

Table 5. CATWOE Expression Method Using ArchiMate.

	<i>ArchiMate Elements</i>
C	Actor
A	Actor
T	Service
W	Principle
O	Actor
E	Driver

Created by the author

Figure 1 shows the results of describing the general education system CATWOE in ArchiMate, based on Table 3.

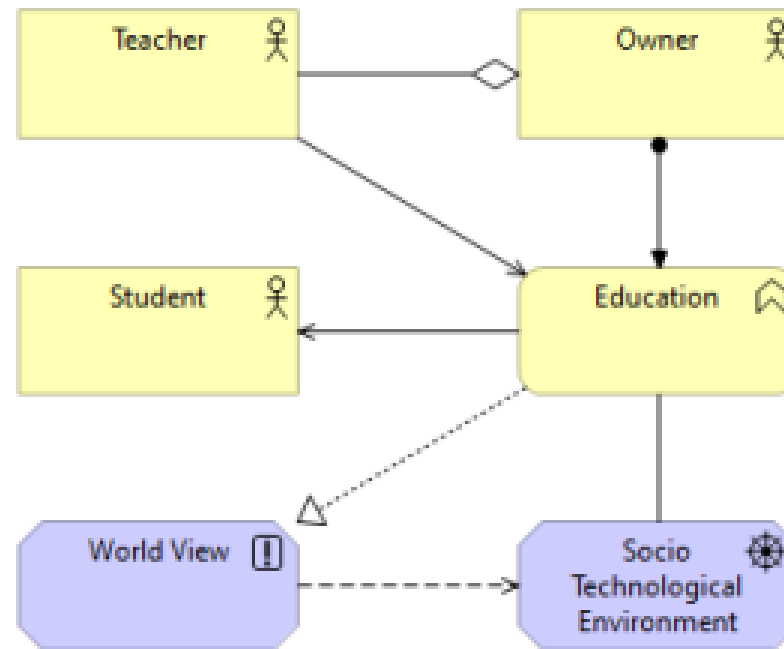


Fig. 1. ArchiMate representation of general education functions.

Next, based on Tables 4 and 5, Figures 2 and 3 show the results of describing HS and OL in ArchiMate.

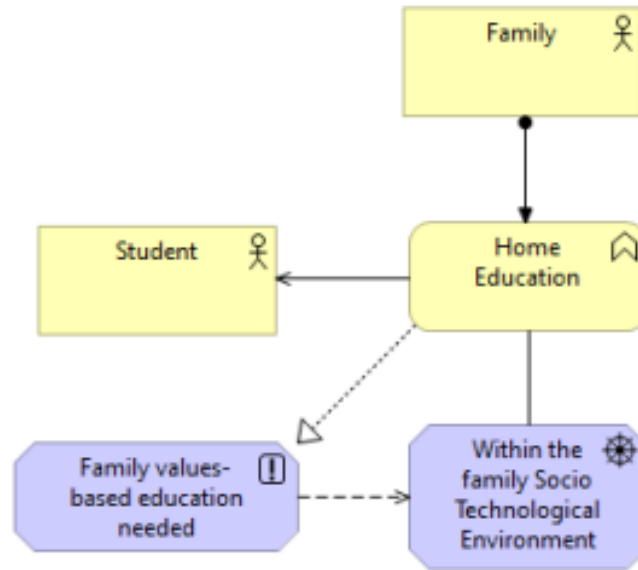


Fig. 2. ArchiMate representation of HS.

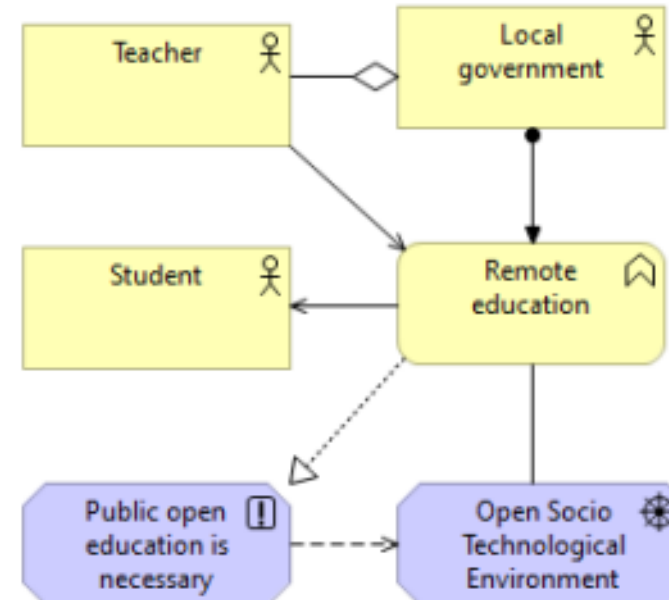


Fig. 3. ArchiMate representation of OL.

Furthermore, since students can use both HS and OL, Figure 4 shows the results of integrating Figures 2 and 3.

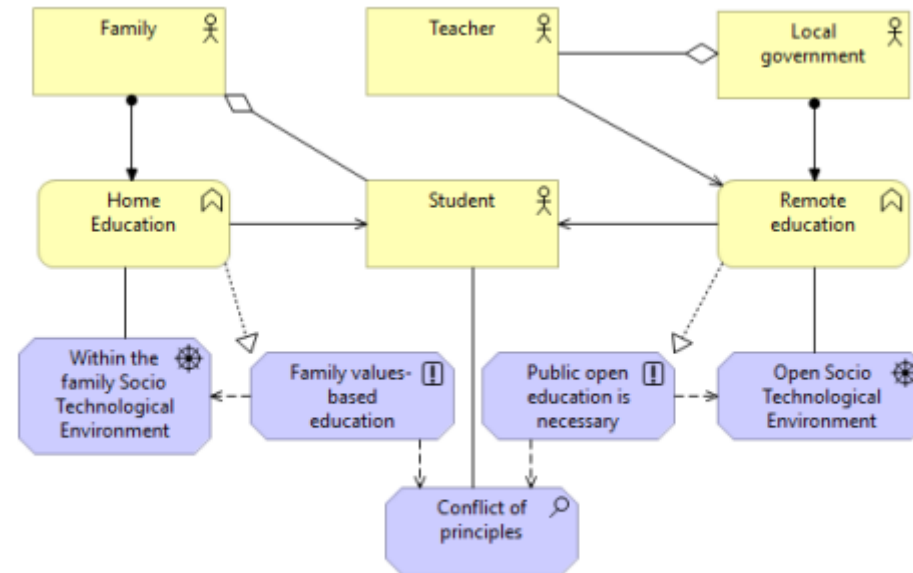


Fig. 4: Integration of HS and OL.

In Figure 4, the possibility of a conflict between family values and public education values and the impact of this on the students who receive education are shown as “Conflict of Principle” using the Assessment element of ArchiMate.

5. DISCUSSION

5.1 Novelty

- We proposed a method for expressing it in ArchiMate based on CATWOE analysis.
- We showed that systems thinking analysis can be used to analyze two different education systems that coexist in the same society: home-schooling(HS) and distance learning (OL).
- We visualized HS and OL in a concise diagram using the EA modelling language ArchiMate to reform the information system.
- We showed that it is possible to integrate HS and OL by clarifying their commonality.
- The general education functions, which consist of owners, teachers, students, and worldviews, were extracted using ArchiMate.
- Above points made it possible to extract issues that were not always clear in the past, such as conflicts in world views in education and conflicts in the principles of conduct that students and teachers must follow due to the impact of these conflicts

5.2 Applicability

In this paper, we proposed a method for expressing the results of CATWOE analysis in ArchiMate. CATWOE analysis, we must stress, is a general method with an incredibly wide range of applicability. This exciting potential is further enhanced by the conversion method from CATWOE elements to ArchiMate elements, which is based on natural relationships. Therefore, the proposed method can potentially be applied to the analysis of other educational systems.

5.3 Limitations

In this paper, we only compare two education systems in British Columbia, Canada, and we do not quantitatively evaluate the proposed method.

In the future, the proposed method must be applied to analyze and evaluate education systems in other countries, such as Japan.

6. CONCLUSIONS

In this paper, we proposed a method for representing the education system using ArchiMate. We also clarified that homeschooling (HS) and online learning (OL) in BC, Canada, can be visualized and that HS and OL can be integrated from the student's perspective.

However, the specific content of the education function was not expressed. In the future, it is necessary to clarify how to represent the content of the education system using ArchiMate and propose a method for expressing specific collaboration methods.

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