Systems mapping, systems practice: Assessment in the primary and secondary education sectors in New Zealand

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Abstract

As part of a review of New Zealand Ministry of Education's national assessment strategy, an exercise to map the assessment system in the primary and secondary education sectors was undertaken. The causal loop modelling (qualitative system dynamics) approach to systems thinking was utilised. Key stakeholders met for a couple of group model building workshops where the main variables associated with the assessment system were identified. Subsequently a smaller group developed a systems map, analysed the main feedback loops, and developed and analysed a range of assessment scenarios. This paper discusses and reflects on this 'systems mapping' exercise.

Keywords

Systems mapping, systems thinking, qualitative system dynamics, causal loop modelling, education assessment, New Zealand primary and secondary education.

INTRODUCTION

The New Zealand (NZ) Ministry of Education (MoE) has been undertaking a project to review the 2001 National Assessment Strategy for the past two years. This strategy includes professional development and provision of tools to support the philosophy of assessment for learning. To date the review project has included a visioning exercise, research, reference group meetings and other activity to develop a framework for the new strategy. This includes a draft vision of 'assessment data used systematically at all levels to support teaching and learning'.

A team of experts has been contracted to develop a final paper on a new assessment strategy to the Ministry by the end of 2008. This group has met and a set of principles for an integrated assessment framework has been developed. As the principles were being worked on several areas were highlighted where unanswered questions remain or more evidence was required. These questions and gaps in evidence have been turned into a series of review papers. This paper discusses a final report that was one of fourteen review papers written for an audience of informed interested teachers as part of the assessment strategy review project.

The 'systems mapping' exercise outlined in this paper, aims to develop an understanding of the assessment system and how various parts of it are linked. It also aims to identify potential leverage points that could be changed in the system to ensure consistency of assessment messages and practices. The initial purpose of developing an educational assessment systems map was: 'To establish the flow of information in relation to the vision for assessment in New Zealand (specifically related to the collection and use of data).'

The assessment vision:

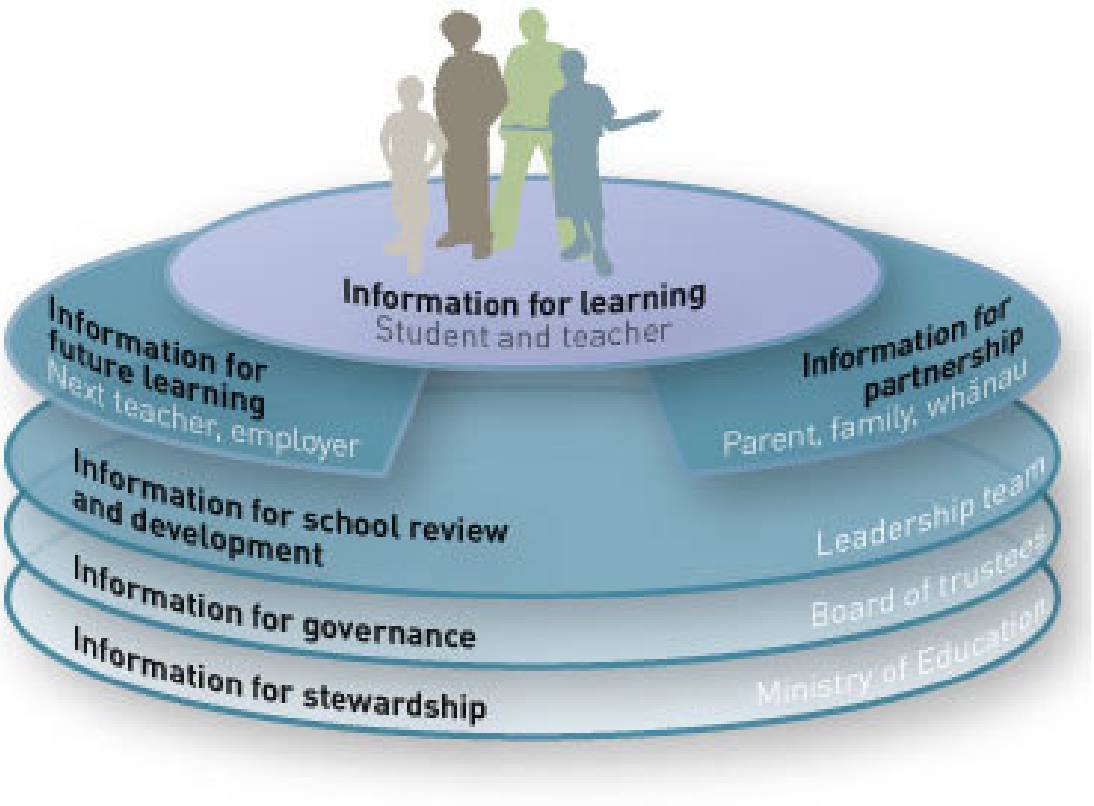
'The vision of the National Assessment Strategy is an education system where assessment data is used systematically to inform decision-making at all levels (assessment for student learning, school improvement, and system improvement) to support improved teaching and learning.'

The Ministry of Education (2007, p40) defines assessment as: "The primary purpose of assessment is to improve students' learning and teachers' teaching as both student and teacher respond to the information that it provides. With this in mind, schools need to consider how they will gather, analyse, and use assessment information so that it is effective in meeting this purpose.

Assessment for the purpose of improving student learning is best understood as an ongoing process that arises out of the interaction between teaching and learning. It involves the focused and timely gathering, analysis, interpretation, and use of information that can provide evidence of student progress. Much of this evidence is "of the moment". Analysis and interpretation often take place in the mind of the teacher, who then uses the insights gained to shape their actions as they continue to work with their students. "

Figure 1 below shows the different groups of people involved in supporting students' learning and the purposes for which they need assessment information.

Figure 1: The uses of assessment information



Source: Ministry of Education, 2007, *The New Zealand Curriculum*, p40.

The structure of this paper is as follows. The next section outlines the methodology and processes used to develop a 'systems map' of the overall assessment system in the primary and secondary education sectors in New Zealand. This includes an overview of the group model building workshops, and a brief discussion related to developing an organising question, the stakeholder map, issue and concept generation, concept clustering and variable identification for developing the causal loop diagram. This is followed by the presentation of the 'systems map' and analysis of

some illustrative balancing and reinforcing feedback loops. Next an example scenario outlining a specific assessment issue is provided, and this scenario is analysed with the assistance of the systems map. Finally some brief conclusions are presented, together with a summary of the main limitations of this research, and some reflections from the participants of this study.

METHODOLOGY

Qualitative System Dynamics

The general methodological approach used for this study is qualitative system dynamics approach to systems thinking. Systems thinking is an emerging discipline for understanding complexity and change (Senge, 1990). Too often in complex problem solving reliance is placed on straightforward cause-and-effect relationships, which ignore the effect on, and feedback from, the entire system. Systems thinking provides tools and techniques to view factors and events within the context of the whole system rather than individual parts; it provides a way to think about the synergy of the entire system. (Refer to Forrester (1961), Coyle (1996), Vennix (1996), Sterman (2000) Maani & Cavana (2007) for further background on system dynamics, and to Wolstenholme & Coyle (1983) for the background to qualitative system dynamics. Recent NZ examples of published systems thinking studies using the qualitative system dynamics approach include Cavana et al (1999) on quality in health services, and Cavana et al (2007) on Army HR issues).

The qualitative system dynamics approach is particularly useful in situations where there is limited data, and the emphasis is on understanding causal relationships between parts or factors within the system. The approach used group model building methods (Vennix 1996) to develop a shared mental model of the 'system', which in turn was used to identify and analyse scenarios related to major issues within the assessment system. Table 1 summarises the main phases of this study, which involved all phases to some extent (except Phase 3 - Dynamic Modelling)

*Table 1: Systems Thinking, System Dynamics Methodology **

Phases	
1	Problem Structuring
2	Causal Loop Modelling
3	Dynamic Modelling
4	Scenario Planning and Modelling
5	Implementation and Organisational Learning

* This methodology is fully outlined in K.E. Maani and R.Y. Cavana (2007), '*Systems Thinking, System Dynamics: Managing Change and Complexity*', Pearson Education (NZ) Ltd, New Zealand.

Processes

A small group of experts from the New Zealand Qualifications authority (NZQA), the Education Review Office (ERO) and the Ministry of Education met to discuss the assessment system, with the assistance of a systems mapping expert from Victoria University. A systems mapping process was used where the group identified a key organising question, identified the main stakeholders and over 100 key factors related to assessment, grouped these factors into key concepts and then identified about 30 variables that represented these key concepts. Further meetings were held by Ministry personnel to refine the variables and reduce them down until there was a manageable number to work with. The next stage in the process was to develop causal loop diagrams (CLDs) to illustrate the impacts different

parts of the assessment system has on each other. A further stage in the process was to develop illustrative scenarios to assess whether the systems map worked or whether there were potential gaps in the map.

A summary of the activities involved at the workshops and subsequent meetings were:

1. Group Model Building (problem structuring approach using hexagon post-it notes)

- Establish an organising question;
- Identify main stakeholders and develop a stakeholder map;
- Identifying issues/obstacles/opportunities/etc & record these on hexagon post-it notes on the whiteboard or clean wall surface;
- Clustering & naming issues;
- Identify variables from clusters.

2. Constructing a Systems Map (Causal Loop Diagram)

- Variable identification & definition;
- Links between pairs of variables;
- Constructing an overall CLD;
- Identifying & analysing feedback loops;

3. Scenario Planning & Modelling

- Development of scenarios;
- Scenario analysis with CLDs.

The final report for this project has not yet been through final consultations with the NZ Qualifications Authority (NZQA), Education Review Office (ERO) and other MoE personnel involved in the original meeting. Required consultation will occur concurrently while the assessment review project final report writers group also considers this paper.

The qualitative system dynamics steps outlined above will now be briefly discussed, together with some issues and comments expressed during each of these different steps.

Developing an 'Organising Question'

At the 1st workshop, the exercise began with the following high level organising question posed to the group:

To what extent are our various assessment systems aligned in ways that give consistent messages to those who must work with them and how might we align them in the future?

The group had an in-depth discussion about the organising question to ensure everyone agreed with it. This discussion noted the following points and questions:

- What is meant by 'system'?
- Who is included in 'our' (which makes it sound personal)? 'Our' could be viewed as centrally provided and mandated by the MoE or also including schools. This was agreed as referring to current NZ assessment systems.
- It makes an assumption either that assessment systems are or aren't aligned.
- It makes an assumption that alignment is a good thing.
- The word 'must' implies compulsion.
- The scope is unclear (it could be about student assessment, assessment of school performance or financial performance etc). The scope was agreed as systems that contribute to student learning and achievement but

needed to identify an outcome. System wide information and evidence (for example international studies) were in scope as they have a link to students although this is not as direct as other work.

- Giving consistent messages doesn't necessarily lead to consistent reception. The group questioned whether there was a consistent understanding of assessment (including the National Certificate of Educational Achievement - NCEA).
- The word 'alignment' is unclear. What needs to be aligned (e.g. methodology, messages)? The group agreed this meant alignment with the National Assessment Strategy and its philosophy of assessment for learning. The group also noted that the NEMP (national education monitoring project) is not currently aligned to assessment for learning.
- The group wondered who 'those' were.

The group then changed the key question to make it more understandable. The final organising question (in the 1st workshop) was agreed as:

To what extent are current assessment systems aligned in ways that give consistent messages to those who work with them and how might we better align them in the future?

In the 2nd workshop, to bring in the purpose of collecting assessment information, the final organising question was further discussed and agreed as:

To what extent are current assessment systems aligned in ways that give consistent messages to those who work with them and how might we better align them in the future, in order to inform teaching and learning at all levels of the system?

Developing a Stakeholder Map

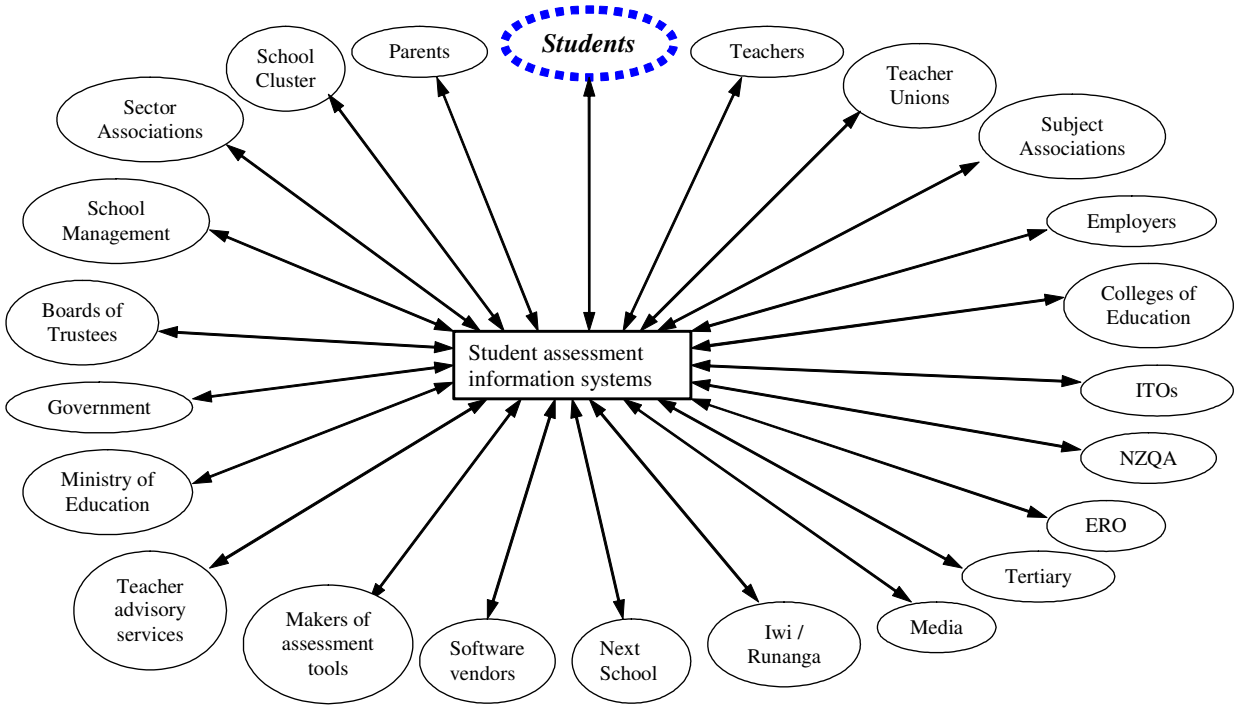
The group brainstormed all the stakeholders involved in student assessment information (the 'those' from the organising question) and made a diagram or stakeholder map (see Figure 2) with lines from each item into a central box representing the relationship flow in both directions (Freeman, 1984).

In the context of a focus on assessment systems that contribute to student learning and achievement the group were asked to think about the stakeholders above in terms of the information they receive (how the information flows to them), the information they need to inform them about students and how they use this information. The following points were noted:

- There is an important flow between the different stakeholder groups (e.g. between teachers and students; teachers and school management etc). This was represented in the diagram by the lines which could be seen as continuous and linking all groups together.
- Each stakeholder group could be broken down further, but this would not be attempted at the workshop.
- Whether 'schools' should be included or whether boards of trustees were the proper legal entity. The group agreed that 'schools' still existed even if boards of trustees didn't.
- Whether 'next school' was a subset of 'schools' or should be a stakeholder in its own right. The transition between schools was discussed with every school having a role (from Early Childhood Education (ECE) to primary and onto intermediate etc). Schools could be defined as previous, current and future. The group agreed to keep 'next school' as a stakeholder in its own right to highlight a leverage point where the system is at its weakest (information flow during the transition).
- The media was seen as a conduit to the broader community.
- The map could be further categorised in many ways with one example being into 'generators of information' and 'readers/takers of information'. Some stakeholders would be in both these categories (e.g. teachers, schools).

- Creators of tests and exams include NZQA, employers, Industry Training Organisations (ITOs, who create unit standards in secondary schools). The NZ Council for Educational Research (NZCER) also creates assessment tools, some of which are financially supported by MoE.
- Another group devises ways of using assessment tools, e.g. software vendors.
- Subject specific groups have influence over curriculum development and are contracted by MoE to undertake standards reviews, e.g. Social Studies Association, Reading Association, Science Teachers Association etc.
- The MoE can be broken down into many stakeholder groups.
- Other groups provide professional development.
- There will be different strengths of or degrees of influence for different stakeholder groups

Figure 2: Stakeholder map for the student assessment information systems



Brain Storming Exercise (Issue & Concept Generation)

The next phase in the process was a brain storming exercise where the group was asked to individually identify general phrases and thoughts related to assessment. These were scribed onto hexagonal post-it notes, numbered by two of the co-authors and fixed to the whiteboard. This exercise led on to a further exercise later where the phrases were grouped. Table 2 below includes a sample of the numbered phrases along with any further descriptions noted.

Table 2: A Sample of the Issues & Concepts Generated

No.	Factor/Phrase	Definition/description
1	Feedback	Between students and teachers
2	Feed forward	Information from this point to improve learning in the future
3	Teacher capability	
4	Student self assessment	
5	National student numbers	
6	Manageability	
7	Student entitlement	All students are entitled to an assessment system which gives them information
8	Data has parametric properties	e.g. what scores mean
9	Building capacity	
10	Qualitative versus quantitative assessment and data	
11	Student voice/understanding of process	
12	Validity of data	
13	timeliness	Of outcome/feedback/results (which have a shelf life and need to go somewhere)
14	Data storage	Where information is held/located (e.g. schools, MoE, NZQA) and whether its available
…	…	…
103	Assessing students with diverse needs	

Clustering Concepts & Defining Variables

Workshop 1

The next stage of the exercise (1st workshop) involved clustering similar ideas together so they could be reduced down to the key ideas. This would allow for the cluster to be named and further reduced to a couple of variables. This was described as a simplifying process after the initial wide net casting.

After the group had clustered the ideas into groups they were asked to work in pairs to name the groups and make further changes as required by shifting factors/phrases into more appropriate groupings. The following tables provide a couple of examples of the groupings, headings and factors/phrases under each group. Some groups had an overarching heading and were broken down under smaller subheadings.

The second stage in the clustering exercise was to find variables to represent the concepts within each cluster group below. These variables could either be soft (e.g. motivation) or hard (e.g. funding) and ways to measure each should be identified if possible. For example motivation could be measured by way of a survey. Wording within the factor statement could also be used as the variable if appropriate. Agreed variables along with their definitions are presented under the clusters below. Also included below is some of the discussion that went into determining what the variables were.

Workshop 2

The group noted that the concepts generated in the first meeting could have been different depending on the make up of the group. A smaller group had been agreed to keep the exercise manageable and wider groups can be consulted with if needed. If wider consultation is needed a timeline should be developed to ensure the project is achievable within the timeframe.

Two of the co-authors agreed to amend definitions if required. The group went through the clusters and variables developed in the first meeting, named these and made sure they were understandable and concepts reduced down. Where variables had spanned more than one cluster these were separated out so there were clear variables under each cluster.

The group noted that none of the variables currently encompass data systems and how they interrelate. This issue was reconsidered later when gaps in the system were discussed.

Information

Cluster 1: Results and outcomes

No.	Factor/Phrase
5	National student numbers
8	Data has parametric properties
12	Validity of data (e.g. representative)
14	Data storage
22	Data quality (e.g. accuracy)
32	Appropriate access
40	Qualifications
45	Cohort comparison
48	Trends/comparisons
52	Reliability
77	School participation

The agreed variables were:

- Quality data
- Appropriate access

Various meanings of access were discussed including: technically accessible; freely available; able to be understood. Access was also discussed as relevant across the system. Access can also raise privacy issues.

Cluster 2: Sharing

No.	Factor/Phrase
37	Transfer to next school
47	Inter-operability
53	moderation
59	Teachers sharing data between institutions
60	Data ownership
71	Reporting
98	Benchmarks

The agreed variable was:

- Data sharing. This also needed to encompass the definition of quality data above. This variable was about ensuring achievement was not lost.

Variables

Variables are defined as something in the assessment system that is able to be changed, or changes, as a result of direct manipulation or from a flow on effect from changes in other parts of the system. These variables could either be soft (e.g. motivation) or hard (e.g. funding) and ways to measure each should be identified if possible. For example motivation could be measured by way of a survey.

Fifteen variables to represent the assessment system were identified using a process of continual reflection and refinement. These 15 variables were summarised, for the purposes of developing the CLD (systems map) in the next section, from over 30 variables identified from the concept clusters discussed above. The agreed variables were provided with their definitions and ways of measuring them. However, only brief definitions for the variables are presented below.

Accountability: Accountability for ensuring student entitlement to quality education is relevant at all levels of the assessment system and is an important variable and key leverage point.

Alignment of assessment purposes: This variable is about whether the purposes of different parts of the assessment system are aligned. It is also about whether messages about assessment are aligned.

Appropriateness of assessment: Assessments used in the classroom should be appropriate (which includes NZ made and authentic) in its design and use. International assessments at the system monitoring level should also be appropriate for NZ.

Benefits of assessment: It is important that the benefits of assessment are communicated and widely understood so stakeholders understand why various assessments are undertaken. It is commonly accepted that assessment can be beneficial but can also have negative impacts if used inappropriately.

Capability: Capability includes diagnostic capability and analytic capability. It also includes quality teaching, professional development and other supports that are available.

Capacity: Capacity refers to human capacity (e.g. number of teachers) as well as infrastructure (e.g. number of buildings, number of computers that can be used for online assessments). Capacity refers to school capacity as well as agency capacity.

Credibility of education system: NZ needs to be viewed both nationally (e.g. government, public, educators) and internationally as having a credible education system.

External environmental influences: External environmental influences are part of the context in which the assessment system operates. External factors which can impact on the assessment system can be many and varied and include political, economic and demographic factors.

Partnerships to support learning: There are many partnerships that can support student learning. These include partnerships between the student, school, home and community. Partnerships may not be of equal strength but nevertheless all relationships are important.

Quality information: Quality information means information and data that is accurate, robust, meaningful and usable (in a useful form) and that is able to be accessed (is available) and understood by those who wish to use it.

Recognition of learner diversity: Recognising the diversity of learners is crucial to ensuring assessment is appropriate for all students. Diverse learners include Maori, migrants (e.g. ESOL), international students, disabled students and students from different ethnic backgrounds including Pacific. Any gender bias in assessment should also be considered.

Student engagement and motivation: Students need to be engaged in (have an active role) and motivated by the assessment process to continue learning. If assessment is done well it should contribute to commitment and ownership of learning from the student perspective.

Student outcomes: Student outcomes are the central driver at the heart of assessment. Assessment is intended to measure student achievement outcomes and development over time. Stakeholder expectations of student outcomes and achievement will shift over time as students make progress.

Using information to inform improvement: All levels of the assessment system should be using assessment information for the purposes of informing improvement (for example, in their teaching practice). Practice should be adapted in light of evidence gathered through assessment. This is relevant to teachers but also at all levels of the system.

Value for money: Value for money is an accounting term about the cost effectiveness of activity in the assessment system and reporting this. Value for money is relevant where decisions are made about investments in assessment and spending assessment related funding.

CAUSAL LOOP DIAGRAMS

A number of causal loop diagrams are presented below which show the series of connections between different variables in the assessment system. Figure 3 below shows how all the variables in the assessment system are linked. Figures 4 & 5 highlight illustrative reinforcing and balancing loops in the system.

Causal loop diagrams provide "*… a framework for seeing interrelationships rather than things, for seeing patterns of change rather than static snapshots*". (Senge, 1990, p68). Chapter 3 of Maani and Cavana (2007, pp 28-58) provides a comprehensive introduction to developing and interpreting causal loop diagrams.

A key to symbols contained in the causal loop diagrams presented in this report is provided in Table 3.

Table 3: Key to Causal Loop Diagrams

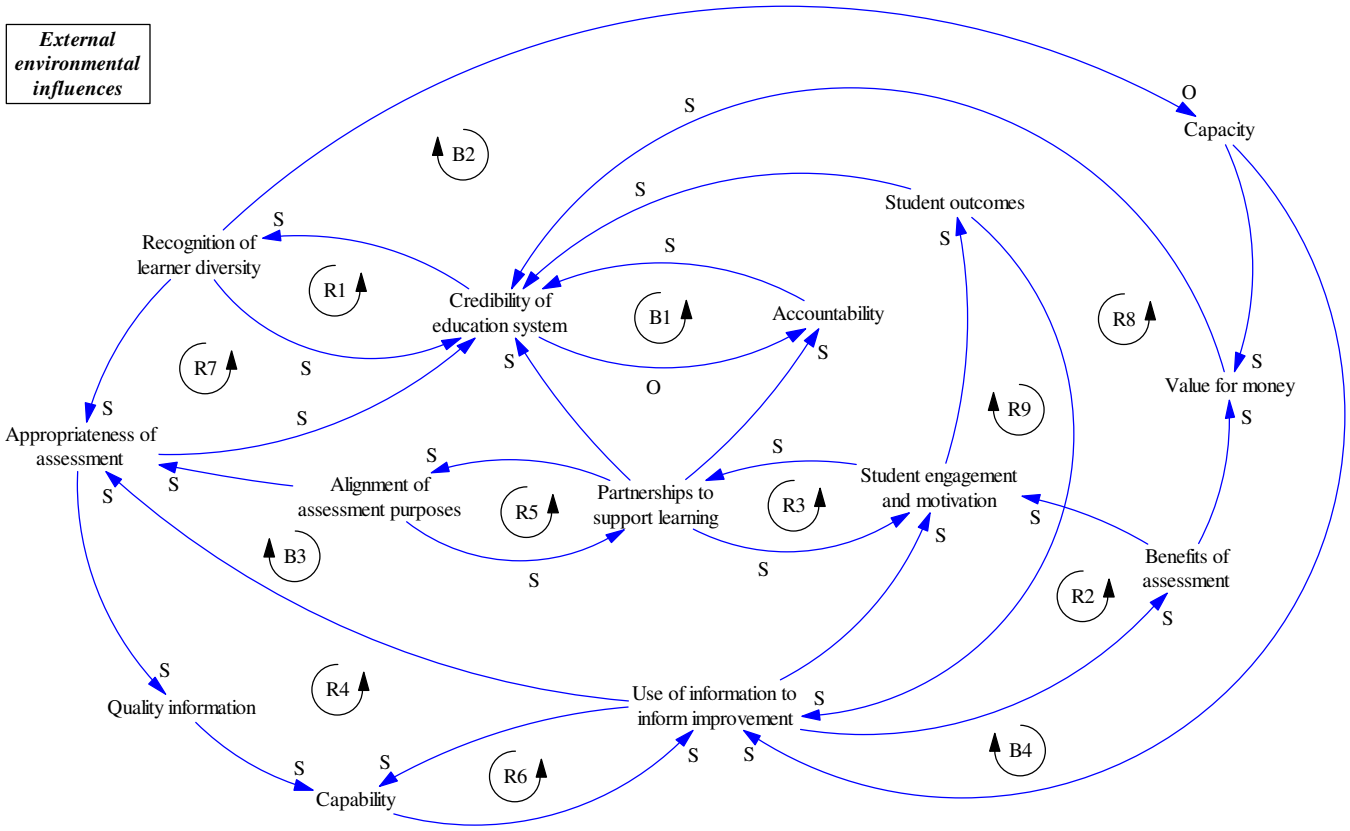
B1	Balancing loop (no. 1) – seeks stability or return to control, or aims for a specified target
R1	Reinforcing loop (no. 1) – are positive feedback loops. They can represent growing or declining actions.
o	Variable at the head of an arrow changes in the opposite direction to the variable at the tail.
s	Variable at the head of an arrow changes in the same direction as the variable at the tail.
→	A causal relationship or influence between variables

Systems Map of NZ Education Assessment

The systems map developed from the group model building workshops and subsequent meetings (using the variables outlined in the previous section) is presented in Figure 3. There are nine major reinforcing loops and four balancing loops in this diagram, however, only one reinforcing loop and one balancing loop will be discussed here.

Figure 3

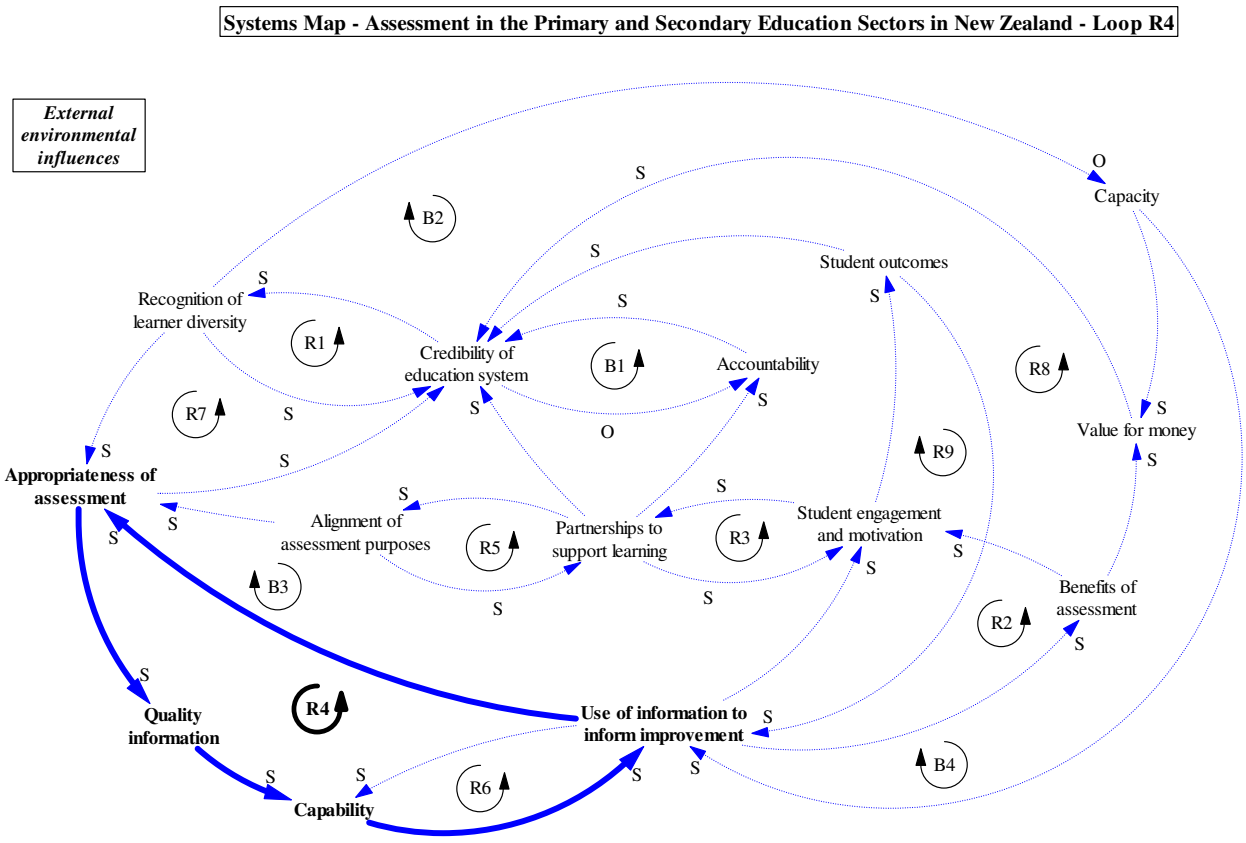
Systems Map - Assessment in the Primary and Secondary Education Sectors in New Zealand



Reinforcing loop four (R4)

The reinforcing loop in Figure 4 illustrates that an increase in the appropriateness of assessment leads to an increase in quality information. An increase in quality information then leads to a corresponding increase in capability within the system; this in turn results in an increased use of information to inform improvement. The increased use of information may lead to changes in practice and have a positive impact on appropriateness of assessment.

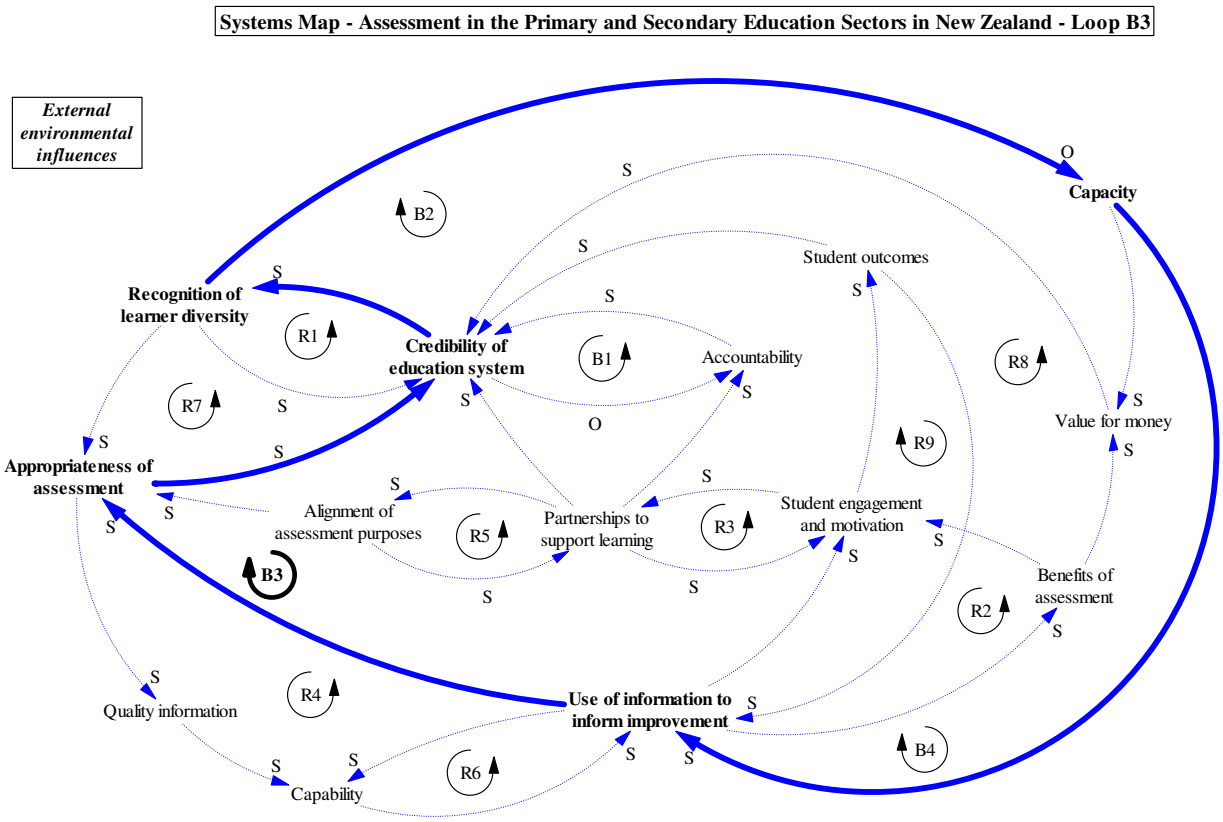
Figure 4



Balancing loop three (B3)

Balancing loop three shows that as recognition of learner diversity increases there is a reduction in the capacity of the system to manage the diversity and to develop a range of separate assessment processes. As capacity is reduced the use of information to inform improvement is reduced, this in turn leads to streamlining of assessment and a reduction in appropriateness of assessment. As assessments become less appropriate the credibility of the education system is reduced, in turn reducing recognition of learner diversity and a 'back to basics', 'one size fits all' system.

Figure 16



Scenarios

Illustrative scenarios have been developed for discussion purposes only. Note that a scenario is not a forecast or an intention to describe a certain future state, but it is intended to provide a possible set of future conditions (Becker, 1983; Maani & Cavana, 2007, Chapter 5). One scenario will be provided here to demonstrate the scenario analysis with the systems map.

Scenario 2 – Communication between parent and teacher

A parent is engaged with their child's education and frequently discusses progress with the teacher and understands what the different levels of achievement and test results mean in relation to how well their child is doing.

The teacher, parent and child work together to identify areas of strength and areas that require further focus. They also identify the types of activities and learning that the student enjoys and that facilitate better learning. In response to such discussions and to support better outcomes the teacher utilises the evidence and information available within the school and from the best evidence literature to develop a range of innovative approaches that are successful in improving student outcomes.

A review of the school's assessment approaches by a government agency identifies that although the school has policies and procedures in place these are not used consistently across the school. The report from the reviewers recommends that the implementation of current policies and procedures should be monitored. The school management requests that teachers follow the current policies and procedures. The teacher attempts to follow the existing guidelines but finds that students are not learning as well, so she reverts back to the approach she had developed and was using before. She tries to bring this issue to the attention of the school management team (by indicating how the policies need updating) but the feedback is not actioned.

Scenario 2 analysis

This scenario relates to reinforcing loops R3, R4 and R9 (see Figure 6 below). As the partnership and contacts between parent and school increases then so does student engagement and motivation (Loop R3). This in turn has a positive impact and increases student outcomes. As student outcomes increase so does the use of information to inform improvement (Loop R9) which leads to more appropriate assessment, higher quality information, and greater capability. Greater capability leads to further use of information to inform improvement (Loop 4) and then back to further enhancement of student engagement and motivation (thus closing Loop 4) and so on.

The virtuous cycle is upset when the school review is undertaken (see the behaviour over time chart in Figure 7). This review is purely for accountability purposes and is not in response to an identified problem or a need for further support, for example. The last paragraph in the scenario shows that there is a misalignment between the practices the teacher is using (which are evidence based and innovative) and the expectations of the school and the knowledge of the outside agency. The teacher follows the school and the reviewer's recommendations but finds a reduction in student outcomes so reverts back to original practice. This scenario highlights a potential gap in the assessment system where school management and government agencies don't keep up to date with informed teacher practice.

Figure 6:

Systems Map - Assessment in the Primary and Secondary Education Sectors in New Zealand - Scenario 2

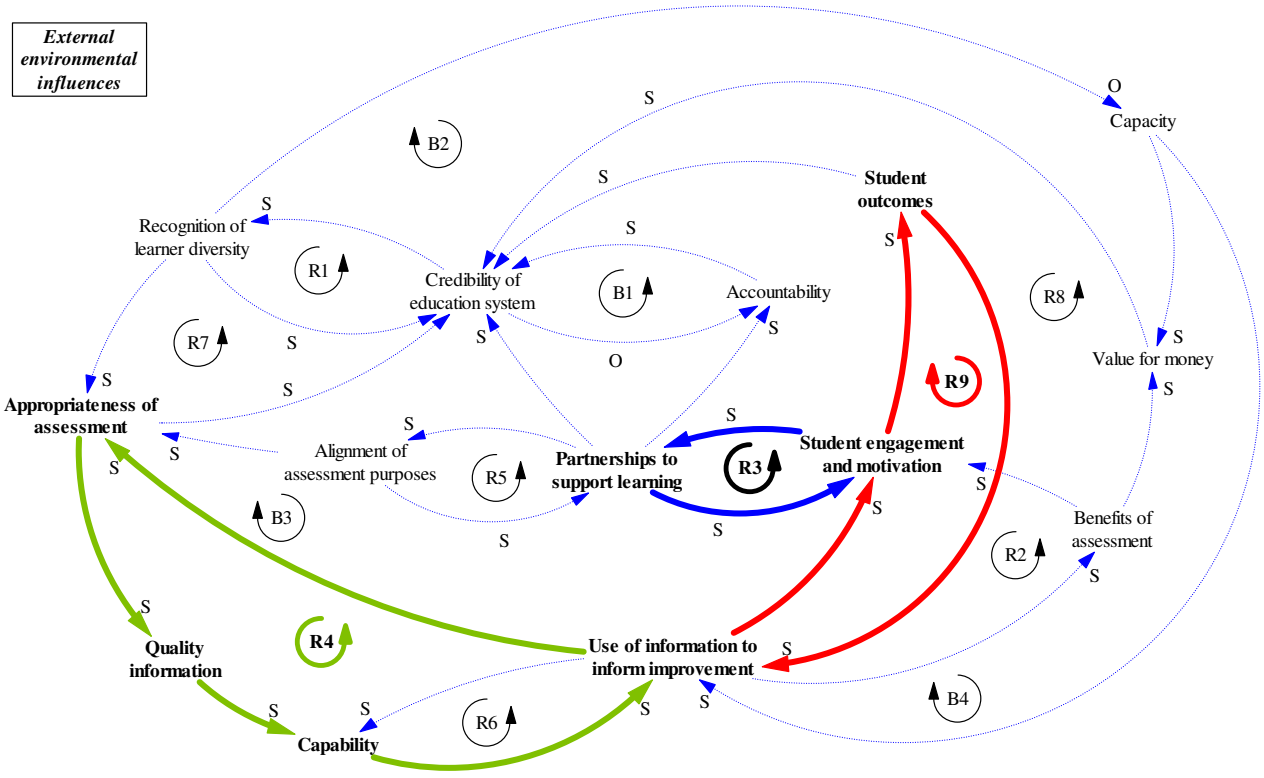
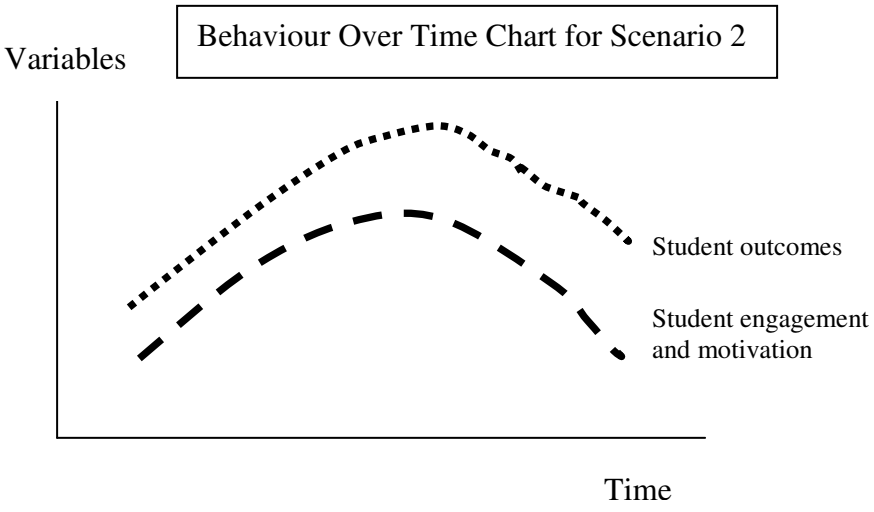


Figure 7



CONCLUSIONS

During analysis of scenarios and comparison with the map developed of the assessment system, a number of key findings have been highlighted:

- The systems map (CLD) provides a useful high level tool to assist understanding of how aspects of the assessment system fit together, however as it is high level only and simplified there is a level of detail not apparent. For example, different partners and their impacts; accountability and the factors within it; long term versus short term impacts on some variables e.g. student outcomes. Also there are some aspects of the assessment system which may not be included adequately in the map altogether, for example, professional development to support teachers, and a possible missing variable somewhere between accountability, alignment of assessment purposes and partnerships to support learning, related to communication. In addition the only stakeholder group that is singled out in the map is students.
- The assessment system is complex with complicated relationships and responsibilities which are not easy to understand or clearly articulated. It may be useful for future work to include development of sub models for particularly complex aspects of the assessment system, such as accountability and partnerships. A sub model for accountability could include elements such as evidence and information used for accountability.
- The systems map works well until the scenarios show a misalignment in the assessment system. These provide key focus points for future work on ensuring the assessment system is aligned. Current analysis has identified a number of points of misalignment in the assessment system, including communication and information sharing between different players in the system.

The main limitations of this study are that it is primarily qualitative, and the variables for the causal loop diagrams were based on the group contributions of those participants that were present. However, although those participants were fairly representative of the wider stakeholder groups that they represented, they have not yet had the opportunity to discuss the systems map that has been developed or the scenarios and analysis outlined in this report. The other major limitation is that a very limited literature review was undertaken for this study. That may also have provided an additional means of validating the variables and relationships in the causal loop diagrams.

Finally, the key points of learning that the participants indicated from this piece of work were a greater appreciation of the complexities within the education system and the range of pressures that drive assessment policy. Also some gained a greater sense of clarity around the need to greater alignment between 'assessment purposes, partnerships for learning, accountability, and student achievement'.

In addition to the insights listed above, the sense that participation in this project provided a new approach to thinking about issues for those participants who have not been formally exposed to systems thinking methodologies

before. Given the small amount of time it took for participants to understand the logic and concepts behind the methodology we suspect that many if not all of them already thought in a systemic kind of way but that it was not a systematically conscious process and they didn't explicitly look for such connections. We know that this piece of qualitative systems modelling work has now made considerations of flow on effects and feedback loops a conscious part of thinking and analysing educational policy issues.

Future research will include an analysis of the feedback and reflections from users of this 'systems mapping' project.

ACKNOWLEDGEMENTS

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