

Research Paper

Enthalpy Change: Firing Enthusiasm for Learning

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Abstract: The paper examines how metaphors play a key role in triggering individual emergence, involving the recognition of a new form, pattern, structure, organisation, model or concept, and then possible behaviour change. Individual emergence is thus of direct interest to the designer of learning systems. Enthalpy change, derived from thermo-chemistry, is mapped to human experience of conversation: within a group, between individuals and to conversations-with-self. Metaphors are also explored as driving agents for triggering personal change and for firing enthusiasm for learning. A model of individual emergence is presented based on metaphors in (1) conversation (2) other external stimuli including learning/training materials (3) internal thought processes. Practical ideas are provided for those involved in learning systems design. The need to provide appropriate metaphor as catalysts to engage the learner, and to sustain learning, is illustrated through example, as is whether specific catalysts are appropriate given the context.

The thrust of this paper, originally presented [1] to the International Society for Professional Innovation Management (ISPIM), has been adapted and extended for the reader's of this Journal.

Introduction

This paper examines how metaphors can be exploited to trigger individual emergence. It is adapted from a paper recently presented to the International Society for Professional Innovation Management (ISPIM) [1].

The model developed here is offered as guidance for those interested in planning and designing learning, and in stimulating behaviour change. To reduce semantic difficulty it is important to provide definition of the terms used. The word metaphor is interpreted broadly, and is assumed to be inclusive of the wide range of images, analogies, concepts, models, theories, and inputs from the outside world that we receive and interpret individually or collectively through our five senses. The term “emergence” comes from the systems science discipline; and is used here in relation to the process of learning and development that brings about future behaviour change.

The International Encyclopaedia for Systems and Cybernetics [2] has the following definitions:

- Emergence – the recognition by an observer of new form, shape, pattern, structure, organisation, model or concept
- Individual emergence – the recognition by an individual of a new order or level of their understanding or competence, or of adjustments to perception or values, which then leads to change in their future behaviour.

For individual emergence to take place, the following phases will be involved (1) exposure to, and recognition of, a new idea (2) internal reflection on that idea set against experience (3) test and acceptance of idea (4) behaviour change.

In practice the use of the terms “emergence” and “individual emergence” can blur, and an example will help to differentiate. Take the context of a junior manager and an appraisal session with their line-manager. During the session the junior manager may come to recognise a pattern of problems of their leadership style (emergence) in certain scenarios. Following training in models of leadership, the junior manager would hopefully demonstrate individual emergence in a capability

to deal with a range of leadership scenarios, in that a new pattern of successful leadership outcomes emerge.

One issue is the extent to which individual emergence can be designed or planned, thus the topic is direct interest to the designer of learning systems.

The paper first makes a link to group emergence (learning within, and change in behaviour of a group). This connects to the author’s earlier work [3] on a metaphor drawn from thermo-chemistry, namely enthalpy change, i.e., the change in internal energy of a system of chemical reactants. Enthalpy change can help to explain how some conversations ignite and sustain on-going interaction between participants so that their potential for creative synergy is maximised, and how other conversations flicker and die.

The paper then shows that the concept of enthalpy change can also provide useful insights on the potential for individual emergence. The enthalpy change metaphor provides the basic framework for considering problems of emergence, but metaphors also emerge as key driving agents for triggering personal change, or for firing enthusiasm for learning. A basic model of individual emergence is presented which assumes trigger categories arising from metaphors used in (1) conversation (2) other external stimuli such as learning/training materials (3) internal thought processes. The paper then discusses which of these categories of stimuli might be more/most/jointly powerful in triggering individual emergence in a range of contexts and gives some pointers for exploiting the ideas in learning design, and for workshops aimed at encouraging change.

Enthalpy change in chemical reactions

Many readers of the interdisciplinary Business Chemistry Journal will well know the concept of enthalpy change in chemical reactions. They will perhaps forgive me for providing a short description of the concept for readers who may be less familiar, and also, because my purpose is to highlight particular features of enthalpy change that can also serve as a metaphor for human interaction.

Bonding changes in some chemical reactions can release energy (enthalpy change) into the chemical system and sustain further reaction. The inherent stability of chemical compounds is because the atoms from which they are made are bonded together. The bonding itself involves energy, so the first step in a reaction between two chemical compounds is an input of energy to break the bonds that already exists. The second step is to make new bonds that will exist in the products. The amount of energy required to start a reaction is called the activation energy - it is simply the height of the "energy barrier" or "energy hill" to overcome the bonding of the first molecules to enable them to react. Figure 1 illustrates the enthalpy change concept.

Assuming the energy released from first interactions between molecules is greater than the activation energy (this is the case in the so-called exothermic reaction) then more molecules can react, and a chain reaction can occur. As the reaction develops, eventually the energy release may be sufficient not only to maintain combustion but also to release excess heat to the environment. The chemical chain reaction can occur if h_2 is greater than h_1 .

It is also important to introduce the concepts of catalyst and reverse reaction. A catalyst is a substance that alters the rate of a chemical reaction but may itself be unchanged at the end of a reaction. They work in various ways but their purpose is always the same - to reduce the

activation energy (h_1). Using a catalyst will allow reaction to proceed with lower energy input. There is another advantage to catalysts, as conditions arise where several reactions, which can lead to different end products, are possible. Catalysts can sometimes be found that are specific to particular reactions taking place. Using a specific catalyst, the reaction that produces the desired product can be enhanced at the expense of other possible reactions. This is an important idea for later discussion on learning design.

Some chemical reactions are reversible, particularly if the products from the reaction are still within the reactant mixture. The reverse reaction means that the products recombine to form the original starting ingredients. However the reverse reaction implies the breaking of bonds that have been made by the forward reaction and energy being diverted from the forward reaction.

Enthalpy change metaphor and group work

The description of chemical reaction provides only a partial explanation of what happens within a situation involving human inter-action say, in group work, or in a conversation. The participants will arrive with external bonds still partly intact. They will be pre-occupied and bonded to their social and professional culture. Hence the equivalent of activation energy will be required to be input to the group to break or loosen these bonds. Some form

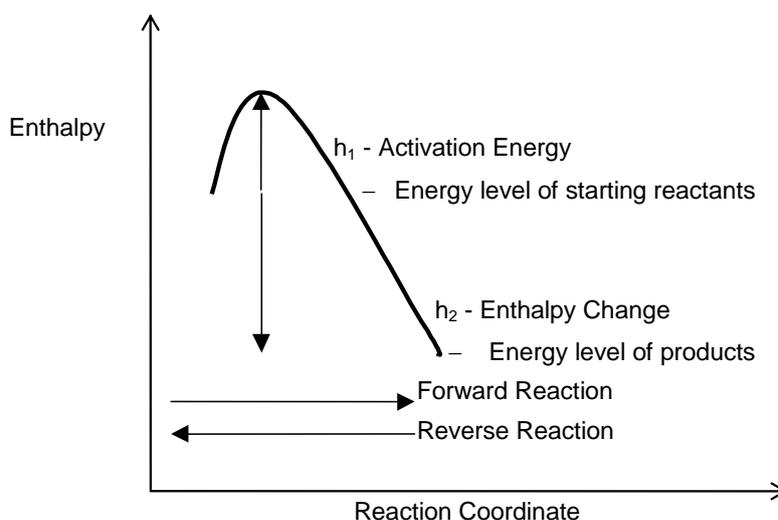


Figure 1: Enthalpy change



of spark must either be generated within the group or be brought in from the environment. The “wheelspin” which is a common experience in conversations can be seen as sparks which had inadequate energy to overcome the energy hill the group faced. But once the right spark has been found, and the group reforms bonds and works collectively, then energy is released - through enthalpy change - to enable them to interact further and “perform”. As the group increases its bonding something akin to the chemical chain reaction is taking place. But something more dramatic will happen in the case of human interaction in that as the starting energies of the participants varies from day to day, not only are the activation energies different but so will the enthalpy changes. Thus any chain reaction which results appears to provide at least a partial explanation to what is usually described as the synergy of human activity systems i.e. the non-repeatability of group interaction and the capacity to produce unexpected results, which are sometimes very creative and positive, and sometimes the opposite.

Continuing the comparison of characteristics of chemical reactions with human inter-action, let us consider the role of catalysts in reducing activation energy, sustaining interaction and reverse reaction. A number of factors can operate individually and collectively as catalysts to reduce the activation energy necessary for conversation to start, for example:

- External environment - may reduce bonding to perceived constraints, and also be a source of inspiration. An “Away Day” - i.e. group work away from the office can be useful to loosen bonds to constraints of social and professional culture
- Internal environment: warmth, comfort, seating arrangements e.g. – a circle of chairs to encourage interaction; place symbolic empty chair in circle to represent those not present but who will be affected by any decisions made
- Circulation or tabling of ideas from input papers
- Opportunities to meet others informally beforehand

- Previously shared or recently emerging ideas
- Imposition of time pressures, or deadlines
- Exploit early opportunity to foster bonding by adopting a flexible style of introductions e.g. rather than self-introductions, form pairs for discussion and then have A introduce B, B introduce A. Encourage participants, if appropriate, to avoid ring-fencing themselves by quoting post and function e.g. “I am from the Accounts”. Suggest they convey a more open description of what they or colleague might be able to bring to the discussion e.g. “My interests are X, Y and Z”. A Japanese colleague of the author conveys his openness by introducing himself as simply as a citizen of Planet Earth.

Conversation largely takes place through sharing and offering metaphor, which reflects the basis of understanding, beliefs and values that the participants hold. As Gregory [4] has said “Conversation is nothing more – and nothing less - than the attempt to model the way in which we manipulate our metaphorical systems to construct shared meaning and thereby, come to agree with one another over what we understand”. To sustain a conversation it is vital that metaphors that are shared are culturally and linguistically appropriate, and also possess structure, depth, and richness with an appropriate degree of familiarity and referencing for the intended purpose. In this way the metaphors serve as catalysts and triggers. For example, it may make no sense to refer to a “round table” to the Bushmen of the Kalahari Desert. The author experienced difficulty in using metaphor in a conversation between US and UK citizens. This was an attempt to convey the need for extreme secrecy, by stating we would need to behave like the Magic Circle. The metaphor was not understood, as there is no Magic Circle in the USA, that in the UK is the professional body which controls and licences magicians to perform professionally, and binds them to not telling non-members how tricks are done.

Also the use of inappropriate images as metaphor can be dangerous, and have a dark side, when used for persuasion, coercion and interpreted too far.

Conversation will be sustained only if the metaphors shared continue to provoke interest and the release of internal energy. The equivalent of a chemical reverse reaction will occur in the group if for any reason relationships in the conversation circle begin to break down. In effect energy is expended to break bonds, at the expense of maintaining the bonds so that energy is available for joint creativity. It follows that the group, or its facilitator, should monitor its behaviour for danger signs. The danger of bond-breaking within the group is likely to happen if any member of the group feels that they are not being given adequate opportunity to contribute, or their freedoms of expression, action or participation is being impaired in some way; or conversely that others are trying to dominate.

A comparison between the chemical reaction and human interaction led the author to propose suggestions for planning and sustaining an effective conversation [5]. A conversation in that sense is an extended form of group dialogue in the context of social systems design as proposed by Banathy [6], that also aims for maximum participation and maximum creative synergy.

Conversation

The context of conversation can vary enormously. The style of conversation proposed by Banathy is a potentially powerful opportunity for change in that it takes place over an extended period with many triggers being generated to sustain bonding and internal energy. Also this context involves willing participants who are generally open to new ideas and to the possibility of change, so that the activation energy required for the group to be productive is low. As Stewart [7] observes:

“Conversation is the antithesis of debate in that it is not based on adversarial premises and does not polarise people. Participants realise that the winning of arguments is not the issue. It opens the discussion rather than channelling it into something that may be difficult to get out of. It enables “change of mind” to occur, without fanfare or fuss. It is the foundation of community building.”

This approach can be usefully employed in workshop contexts. For example, in a business setting where there has been some conflict between departments because of difference in their professional culture. This may be the case in an R&D setting where say, the R&D engineers and finance office have clashed over speed of ordering and purchase of components to support tests and trials. The engineers have looked for a very rapid response to their requests for components, but finance want to place orders through an established system.

Not all conversations will begin in the ideal open way proposed by Stewart, indeed they may not even start, especially where there is a history of conflict or major cultural difference, or where there are fundamentalist views present. Cultural differences of this kind may be seen as a very high level of activation energy acting to prevent the formation of new bonds. Action research into conversation, for example for peace treaties, stresses the need to search for those visions which are common and transcultural rather for those issues which differentiate positions and are inter-cultural. Methods advocated are to be found in Bohm [8], and in Banathy and Jenlink (Eds.), [9]. These typically suggest a period of generative dialogue before strategic dialogue.

Shorter conversations whether open or adversarial, may have less effect but even within a short exchange, if metaphors offered by one person engage the interest of another, then individual emergence is possible. We also note the inevitability of unexpected outcomes arising through engaging with metaphors provided in conversation.

Mental Map and Perception Mask

Let us begin by considering how an individual develops a mental map of their experiences. Over time, this map is built up, revised and reinforced over time and experience, by the range of stimuli present in their environment, and in their own social and professional culture; e.g. through:

- Touch, taste, smell
- Sound
 - Spoken language
 - Music
 - Natural sounds
- Sight
 - Symbolic language
 - Written text
 - Mathematical and conceptual models
 - Diagrams
 - Shape, size, colour,
 - Art: drama, poetry
 - Story: fiction, selective facts, science fiction, myths and legends, fantasy
- Collective senses
 - Natural and man-built world

All these metaphors, particularly the images and story, provide the basis for individuals to understand and rationalise the external world around them. Over time this leads to a set of core values, beliefs and to a “perception mask”, which taken together we can regard as “self”. This mask can be an obstacle for change.

Exposure to any new stimuli in one’s external world can be random e.g. unexpected recall or sight of a scene of outstanding natural beauty, or the recall or hearing of a remark by another. Opportunity for new stimuli may also be planned e.g. by travelling, embarking on a new course of study, or going to a lecture. If any subsequent new stimuli are of sufficient interest to overcome the activation energy required to produce a “conversation with self” and deep reflection, this too can lead to internal synthesis and transformation. We may call this creative synergy-with-self. If the interest and connection with triggering metaphors is sustained and strong enough, the creative synergy-with-self can lead to excitement and enthusiasm for learning and then

to adjustments in the individual’s perception mask and to individual emergence.

However, the non-repeatability of group interaction (because of variable enthalpy change) and the capacity to produce unexpected results, also applies to “conversation with self”. The individual’s starting energy varies from day to day, as will the impact of the trigger and the activation energy required to connect to it; thus the enthalpy change will vary. Thus the effects of the same trigger on an individual can vary, they are sometimes very creative and positive, and sometimes the opposite. It is clear from everyday experience that the same triggers on different individuals can potentially produce very different effects. This is a key issue for those who are involved in the design of learning systems (see below), which are usually intended to produce individual emergence.

Enthalpy change and individual emergence

Figure 2 shows a conversation between participants A and B, each with their own perception mask. A dialogue is illustrated as the simplest version of a group exchange. The diagram shows that if care is taken to trigger and sustain communication through catalysts and appropriate metaphors that are accessible to both, then temporary bonding and positive creative synergy can result. If appropriate transcultural triggers and metaphors are provided over a period then a deeper reflection – synergy-with-self can occur. This can then lead to a shift in perception mask and individual emergence in either or both A and B, i.e. there can be collective emergence.

Given the issues previously raised relating to cultural difference, it follows that conversation to achieve maximum creative synergy is a practice requiring considerable skill. In many contexts, say, where there has been family or work-based conflict, a skilled intermediary is required to sustain a communication aimed at resolution.

One research theme within systems science over the last 10-15 years has been linked to conversation design and practice, how to avoid conversation breakdown and how to disseminate the knowledge gained. The ideas in this paper are incorporated into the body of knowledge of this

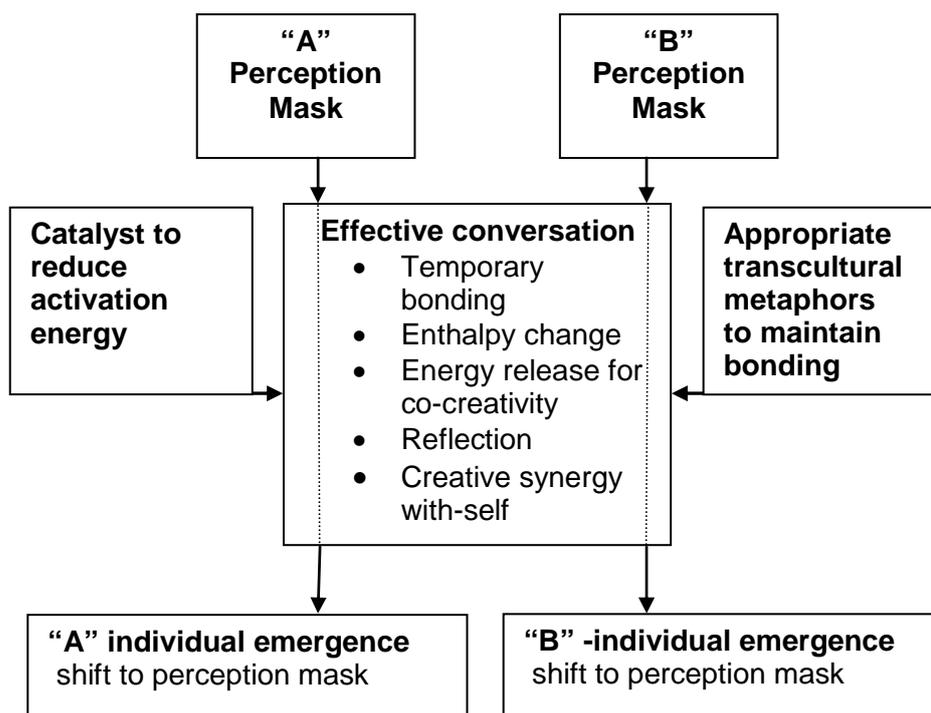


Figure 2: Enthalpy metaphor framework explaining emergence

“social systems design” activity, Banathy [6] (op cit), and in linked action research of the International Systems Institute [10]. This paper offers the opportunity to diffuse the ideas into a separate discipline area.

Exploring the model

The model proposes that individual emergence is possible through metaphors arising from 3 different types of source:

1. Conversation with others (as described above)
2. Other external stimuli
3. Internal thought processes (reflection).

These three constitute a system of sources in that they can act either singly or jointly, or sequentially, and might themselves be connected in certain contexts. Whatever the source, if the trigger is strong enough, a “conversation-with-self” may ensue, sometimes immediately or after a delay. The intensity of this may be strongest in (1) and least in (3), especially if the conversation is

extended. This is because conversation with others involves two-way (or n-way) interactions, and potentially provides many and variety of triggers to sustain communication, to release energy to sustain reflection and thus adjust the perception mask to produce change within the individual. Clearly time and depth of engagement in conversation is crucial. There may be other factors at play.

In a case of (2), for example, if the input is via newsprint or other forms of printed material, the interaction is one-way. Thus careful design is necessary to ensure that attention of the reader is maintained and that necessary regular triggers are present throughout. The case of a newspaper is interesting in that it is designed to prevent emergence and change in the reader. We tend to buy the newspaper that tells us what we want to read and can be upset if our paper is not available when we come to buy it. This is because each day “our” newspaper typically reinforces our perception mask, and uses metaphors and images with which we are most familiar and content. This is because newspapers often support a particular political agenda so images will either reinforce our

perception of our political persuasion as good, or reinforce the perception of the other side, as bad.

In the case of (3), emergence is least likely for most people by this source acting alone. Though this does not discount the possibility of occasional sudden extraordinary insight from within any individual; it is more likely within the creative artist or genius.

The context will lead to a variation in conclusions about which of the 3 components of the model: (1) conversation (2) other external stimuli (3) internal thought processes, may be more/most/jointly powerful in triggering emergence. Let us examine context through considering sources, whether the exposure to the source is planned or not, and the case of inappropriate triggers.

Design of learning systems

The range of potential stimuli in one's external world listed is enormous, and the impact of them will vary from individual to individual. Interestingly, the range of stimuli, which in one's own social and professional culture reinforce one's perception mask, are also available to learning designers to trigger emergence. The choice of which is clearly context dependent. The role of art-based metaphors can be crucial, in that new visions of alternative futures can be introduced to set alongside the story, poetry, myths and legends of the past.

We also recognise that one person might be moved to tears, another unaffected, or another laugh at the same image. However, this type of temporary individual emergence is of less interest, compared to an emergence that leads to permanent new thinking or behaviour patterns. The enthalpy metaphor reminds us that for the internal conversation-with-self to be sustained and individual emergence to occur, then we must provide regular stimuli or appropriate metaphorical triggers.

This is of practical significance in the context of the design of learning systems, as it reinforces the need for interest and variety in its presentation, and the crucial need for it to be based around appropriate metaphors as catalysts. Some examples will illustrate the idea:

- In teaching young children how to add or multiply, age will be a factor in determining types of images to use. For very young children, images of soft animals may be appropriate, i.e. one rabbit add two rabbits make three rabbits. For the slightly older, we could approach the teaching of multiplication tables by using images of football teams, e.g. how many players are there in five football teams? six football teams?
- For teaching integration to 18 year-olds, a relevant metaphor for them could be an exercise to find the volume generated by rotating a shallow parabola around the X-axis, in such a way that it forms the shape of a beer mug.
- A secondary school teacher shared an exercise with me for teaching textile design, including needlecraft and sewing, to a group of inner city multiracial 14 year-old youths. A real challenge! She presents the task of using a sewing machine as a driving lesson by using the form of racetrack template, shown below in Figure 3, around which they are challenged to sew. The sewing skills needed are presented as the driving skill of keeping as close possible to the centre of the road. The boys tackle this driving task with great enthusiasm.

The idea of regular triggers provides a supporting rationale for the Open University's approach to design of its learning materials, where typically on every page, interest and activity is incorporated to engage the learner, other than the written word. The item of interest can be a photo, diagram, graph or model etc along with something for the learner to do. This could be to answer a reflective question about that item or link to text, or reinforce what been taught or demonstrated by asking the learner to do a calculation or other exercise. Reinforcement can also be applied by switching to other forms of multi-media such as audio, video or web-based material, to on-line conferences.

The same general considerations for interest and variety apply to the delivery of a lecture. Again, as with conversation-based triggers, there is the distinct possibility of unexpected responses in

individuals when exposed to learning materials we have designed, or presentations we give. This may or may not be desirable depending on the context of the learning system. If the learning system is one where there are precise student objectives, then too many unexpected responses will be undesirable. Drawing on the metaphor of the chemical reaction, it may be important to develop specific catalysts for triggers where these can be identified. Evaluation will be necessary to confirm that the catalysts have acted in a specific way and that this is what is required.

It is impossible to remove all variety of individual emergence in programmes of learning, indeed it would be highly undesirable to do so. This is particularly the case in programmes that are seeking to enhance creativity and design in individuals. This is typically also the case in non-mathematical programmes of learning. Catalysts will be required but not those intended to produce a specific response.

Internal thought processes

A sudden unexpected thought can act as an initial trigger, but as has been argued above by itself for most people is normally insufficient for individual emergence. The initial idea is more likely to cause the individual to seek a conversation with others, or seek other external stimuli e.g. undertake research for models. It can also lead to a period of deep reflection, if the individual becomes bonded to the idea or image. Periods of reflection may also be planned as part of a process of thinking about ideas offered by others “Let me think about it and I will get back to you”. Periods of reflection are often planned as part of learning systems e.g. workshops.

As with conversation and other external stimuli, while the opportunity for thinking can be planned, the outcome cannot be determined. Siler [11] has proposed that individuals can be trained to think in more logical and effective ways. His suggested technique involves deliberately contrasting the new issue with a range of metaphor types. In contrast

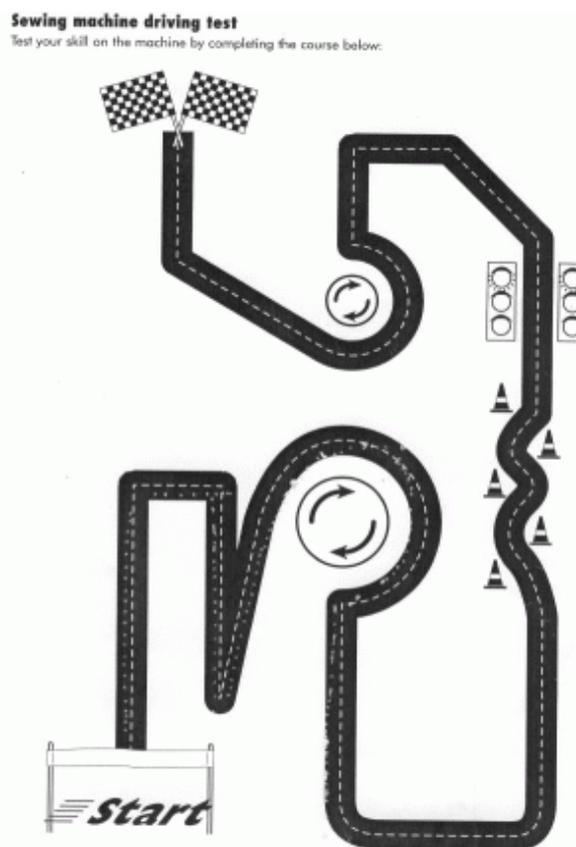


Figure 3: Sewing Machine Driving Test – An appropriate metaphor for the teaching challenge

to the author's inclusive definition of metaphor for the same meaning, he writes "metaphorming, refers to the act of changing something from one state of matter and meaning to another. It begins with transferring new meanings and associations from one object to another" and "Metaphorming involves not just metaphor...but all means of making connections: analogy, figure of speech, symbol, story, pun, story-writing and story telling, scenario making, visualising, hypothesising". Siler refers to making connections, whereas the author prefers to use bonding, as this is consonant with the enthalpy metaphor and the release of internal energy after bonding to sustain the thinking process.

Evaluation of model

Given below is a mapping of the three-source model against the development of this paper and the learning process of the author in writing it. The bracketed numbers in the following description relate to the 3 different categories of source defined above. The initial trigger to participate in the ISPIM 2007 conference learning opportunity was the external stimulus (2) - the call for papers. This was followed by internal reflection (3) - to what extent did the internal metaphor based on 2005 and 2006 conference experiences meet personal needs? This released the energy to begin thinking and writing, drawing on concepts and evidence in external references (2) and on the images and concepts that already existed within self (3) to produce an abstract of the likely paper. After this stage a conversation (1) with a colleague provided further stimuli for reflection following his suggestions to invite conference participants or readers to apply the model themselves. The later stage of the development of the paper was further reading and developing concepts previously explored (2) and then seeking coherence in the ordering and presentation of the ideas, to the author's understanding (3) of the standards required of an academic paper. The final phases involved: reflection on the style of presentation (3) needed at the conference, a conversation with another colleague to seek feedback (1), and a final review of the draft (3). Feedback at the conference (1 and 2) allowed for re-evaluation (3) of the model.

The challenge of submitting to this Journal required further reflection (3), and then necessary adaptation and extension of the paper to try to ensure that it would meet the new audience needs. As a result the author has also undergone yet further individual emergence.

Conclusion

An enthalpy change metaphor provides a useful framework for exploring individual and group emergence. The characteristics of chemical reactions, including activation energy, catalyst, specific catalyst, bonding changes and enthalpy change (energy release) give powerful insights into planning and participation in conversation aimed at sustaining interaction and maximising the potential for creative synergy.

Metaphors also emerge as key driving agents for triggering and sustaining progress towards individual emergence in terms of new learning, understanding, perception and future behaviour change. The model of individual emergence presented here assumes sources of metaphor from (1) conversation (2) other external stimuli (3) internal thought processes. From personal experience and other examples explored, the context is critical in determining which source is most likely to provide the necessary metaphors to initiate an emergence process in an individual, and which source(s) are most powerful in sustaining the emergence. Practical ideas emerge for those who are involved in the design of learning systems and change focussed workshops, namely the need to provide appropriate metaphor as catalysts to engage the learner, to continue to provide metaphors to sustain the learning, and whether specific catalysts are desirable. The paper has highlighted some of the difficulties associated with individual emergence; we can plan programmes for learners but we must always be alert to the possibility that their emergence will not be as we expect. We recognise that culture, values, current knowledge, and interests represent high activation energy levels, which can act against an individual engaging in a learning/change process; the challenge is to find context relevant catalysts to reduce the activation energy level.

This paper is offered as a guide to consider the issue of individual emergence. These ideas have come from the discipline of social system design,

but it is hoped that readers interested in learning design can apply the ideas to suit needs in their own context.

Readers are invited to reflect on what represented the key sources of their emergence during the reading of this paper, and to contact the author with any reflections.

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