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The Role of Student Agency in Bridging Informal and Formal Learning

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1 Introduction

Agency has been described as “the socioculturally mediated capacity to act” (Ahearn, 2001). Educational research often frames this capacity to act in terms of motivation emerging from an internal disposition (Eccles et al, 1993; Guthrie & Davis, 2003; Ivey, 1999; Wigfield, Eccles, & Rodriguez, 1998). Underpinning this stance is the assumption that the capacity to act is located within the individual. Consequently, there has been insufficient attention paid to how other people and objects in a given social context can catalyze and mold the individual’s actions and propel him/her along a learning trajectory. Therefore, in this paper, we propose a shift from an examination of motivation to the study of agency, particularly in relation to the effect of networked relations between people and/or objects.

Studies on agency have provided insights into different facets of this construct. Some of these studies examine agency with respect to the choices people make about texts, reading pace, and activities as they engage in meaning-making (Guthrie & Davis, 2003; Greenleaf, Schoenbach, Cziko, Mueller, 2001; Heron, 2003; Ivey, 1999; Mitchell and Reid-Walsh, 2003; Sullivan, 1991). Other studies consider how society facilitates or limits agency in relation to positions within social networks, commitment to familial and tribal or ethnic relations, and access to knowledge critical to livelihood and career prospects (Gallagher, 2007; Hinchman, Alvermann, Boyd, Brozo, & Vacca, 2004; Mazak, 2007; Moje & Lewis, 2007; Moje, 2000; O’Neil, 2007; Perry, 2007). However, few studies have traced at a microgenetic level the interplay of the individual and the objects in a given social context and how this gives rise to young people acting agentively as text interpreter and producer.

The small-scale examination described in this paper is part of two larger studies in which students participating in a physics curricular programme made linkages between their chosen out-of-school texts and several physics concepts learnt in school. This paper reports on two cases—one in Singapore and the other in the US—in which students act deliberately and strategically to engage in science literacy practices that are being developed in the curricular programme. It explores how high-achieving students in different ways creatively accessed, navigated and integrated out-of-school and in-school discourses as “convertible and transformative resources” (Luke, 2003, p.139) to support and nurture their learning of physics. The paper thus represents an attempt to, first, address questions of student agency, that is, when, how, and why young people decide to engage in learning and extend their own learning across contexts (Moore & Cunningham, 2006). Second, it seeks to ascertain whether there are teaching practices or learning environments that could be leveraged to enhance the sense of agency in adolescents who do not achieve at high levels in school.

2 Theoretical Frame

We begin by explicating the notion of agency upon which our analysis is based. Agency may be conceived as “[t]he strategic making and remaking of ourselves, identities, activities, relationships, cultural tools and resources, and histories, as embedded within relations of power” (Moje and Lewis, 2007, p.18). It is closely related to identity. However, the key difference is that identity reflects who we are, whereas agency is the active making of who we are and will to be. Agency is enacted to shape our identity, that is, the way we wish to be or appear to another to give us

access to the economic, social and cultural capital we so desire (Bourdieu, 1977). It is, therefore, very much tied how we relate to people, communities and artefacts across time and space.

As such, we have chosen to view agency from the perspective of Actor Network Theory (ANT) where it is construed as arising from and being distributed amongst interactions between people and objects in networks. These interactions may be conceived in terms of orientation, directionality, and proximity (Leander and Lovvorn, 2006). Leander and Lovvorn (2006, p.301) caution against locating agency within individuals, artifacts, technology or structures as this could lead to “romanticizing” humans and their practices or a “naïve formalism” and “technocentrism” as texts, tools and structures are then perceived as some kind of magic bullet. The intent in ANT, therefore, is to identify and understand the networked relations which give rise to agency.

3 Methodology

The purpose of the larger study was to create a learning environment where students interacted with multiple genres of texts, e.g. out-of-school and school science texts. This was achieved by means of a curricular intervention aimed at helping students connect informal and formal learning in science. In this curriculum, students chose an out-of-school text (e.g., magazine, video, TV episode) and applied disciplinary content to analyse the text. The first study was conducted in a high school (grade 9-11) honors physics class in Michigan, USA. The second study was held in a high school (grade 11) GCE A-level physics course in Singapore. The data sources from both studies include students’ selection of out-of-school texts and student artefacts and interviews. We selected one case from each of the aforementioned studies—Lucy (USA) and Shen (Singapore). Each of them served as an instrumental case study, helping to provide insight into our understanding of how agency materialised (Stake, 2000).

Our data analysis sought to answer the question of how agency is realised when students come into contact with texts used in different contexts, serving different purposes and audiences. To address this question, we carried out a microgenetic analysis (Kuhn, 1995; Siegler & Crowley, 1991) of the interview data. We adopted Clarke’s (2005) qualitative method of analysis called *situational mapping*. This method enabled us to articulate the elements in a situation of inquiry and the centrality of the role they played within this situation. It also facilitated a thorough examination of the relations amongst these elements. As such, the students’ agentic moves are identified by means of a relational analysis of their chosen artefacts and discourses across time and space. This relational analysis enabled us to address questions of student agency—how it can be realised, construed and examined. Nevertheless, it is important to note that such situational maps only provide a snapshot of these relations within a given timeframe. Such relations can change considerably through negotiations, re-positionings, and the addition and deletion of people and objects (Clarke, 2005).

4 Analysis and Findings

Our generalising categories are drawn from Clarke’s (2005) work which is itself based on Strauss’s (1993:252) several “general orders” within his negotiated/processual ordering framework. For the purposes of our analysis, we have

chosen to focus on the interactions between one “individual human actor” (the student) and the full range of “non-human actants” such as their chosen out-of-school texts, their physics textbook, school assignment, and Internet resources.

In our analysis, we traced the moves the two individuals (Lucy and Shen) undertook between the various non-human actants in their network. The directionality of these moves is reflected in the arrows shown in Figure 1 and Figure 2. The one-way arrows indicate how the student’s interaction with one text led to his/her interaction with a subsequent text. The two-way arrows reflect iterative movement between two texts. All nodes represent texts which contributed towards the students’ efforts at completing the assignment task. More specifically, these texts (i) initiated changes in the way the student interacted with existing texts in her life and/or (ii) catalyzed interactions with new texts. We used the node size to distinguish the centrality of the role played by each text in the network. This centrality was determined by the number of links to a given text. The nodes are numbered based on the sequence of text interaction described by the student during the course of the interview. Texts within the formal domain are encircled in red and texts within the informal domain are encircled in green.

Case 1

Lucy, a veteran in the school colorguard team, spent a lot of time in colorguard practice. During the curricular programme, she had to tackle the assignment tasks which required her to identify a media resource depicting a phenomenon she was interested in and considered relevant and apply the notion of force and its relevant equations. She chose an amateur video of a colorguard toss on Youtube made by a student to illustrate physics principles. She drew from her personal experience of tossing a rifle where she placed a bit of tape on her rifle to help her take note of the pivot point. She said that she did not use the school physics textbook much but turned to the Internet search instead. She did not specify how she used the Internet or what she searched for. She had a notebook for jotting down physics equations she came across in tests. This was for identifying relevant equations as the starting point for tackling what she considered the mathematical aspect of the assignment. She also included a diagram to show the direction of hand movements (i.e. force) when a toss occurred in her written explanation. Table 1 (below) lists all the non-human actants she interacted with during the curricular programme.

Table 1: Lucy’s texts from the formal and informal domains

Formal Domain	Informal Domain
<ul style="list-style-type: none"> • Assignment task • A notebook with physics equations learned during the course • Written explanation, with a self-drawn diagram, equations and a calculation 	<ul style="list-style-type: none"> • Personal experience of tossing a color guard rifle • Out-of-school text: A video clip of a color guard toss • Internet search

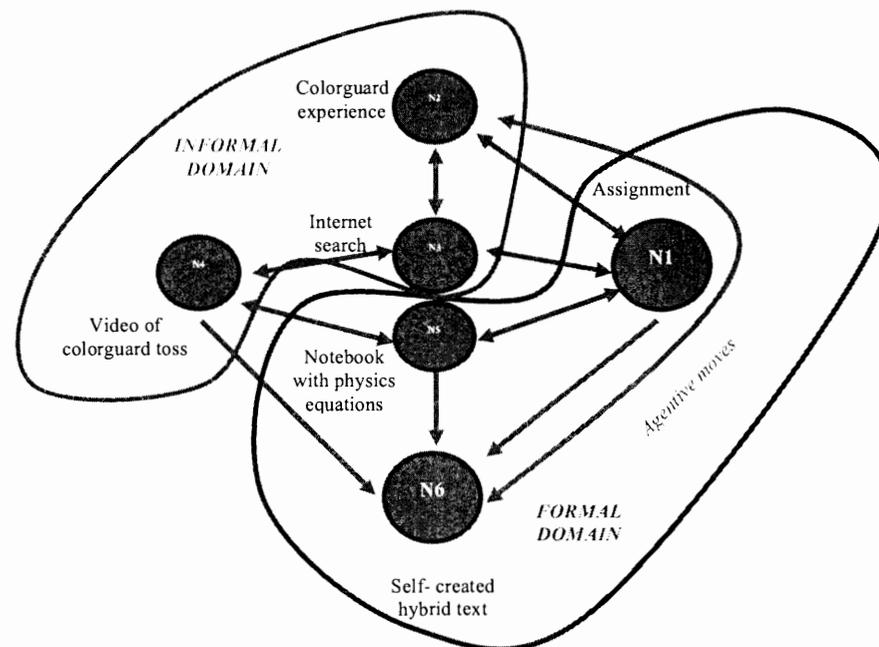


Figure 1: Lucy's agentic moves across texts from the formal and informal domains

We looked at the agentic moves she undertook as she negotiated various texts to complete the assignment task. The first node (N1) was her assignment task. She connected her understanding of the assignment task with her colorguard experiences (N2) to help her make a decision about which video on the Internet (N3) to select. Her colorguard experience thus mediated her interactions with the media resources on Youtube resulting in her selection of a specific amateur video on colorguard tosses (N4). Lucy then followed up by drawing on more texts to support her efforts at completing the task. She drew on her personal experience of colorguard tosses (N2) and referred to her notebook with physics equations (N5) to help her apply and explain the physics concept of force in relation to toss. Her interactions with a variety of texts concluded with her production of a self-created hybrid text (but primarily academic text) (N6) comprising a written explanation of how the notion of force can be applied to a colorguard toss, a self-drawn diagram with some resemblance to a vector diagram illustrating the direction of the force, and equations and a calculation for the forces in operation.

These agentic moves across the various texts illustrate how Lucy navigated texts across the formal and informal different domains in order to complete her assignment. We see a learning trajectory which began and ended with the texts (i.e. the assignment task and the self-created hybrid text) in the formal domain which played a central role in the network. These texts are the *raison d'être* for her interactions with other texts within the network. Nevertheless, the other texts are what we will concern ourselves with as these were the texts Lucy herself brought into the network to support her learning endeavour. Lucy demonstrated that she could with ease identify a video clip depicting a physics concept because her personal experience of colorguard mediated her interactions with her chosen clip. This suggests that when students possess personal knowledge and/or experience of a phenomenon in the informal domain, they

were far more likely to be able to perceive salient connections with the formal domain. More significantly, the texts which Lucy brought into her network were all notably hybridized to some extent. The video clip of the colorguard tosses had already incorporated some explanation of the notion of force. Her notebook contained physics equations which she had gleaned from her lessons. Lucy also chose not to refer to her school physics textbook to develop her explanations and evaluation for her assignment. It is probable that, in Lucy’s case, she found the texts which had undergone some degree of processing more accessible and more useful in helping her bridge the formal and informal domains.

Case 2

Shen, an avid sci-fi fan and video gamer, first watched the sci-fi TV series Fringe when he was 12. He too tackled the assignment task which required him to identify a media resource depicting a phenomenon he was interested in and considered relevant and apply physics concepts and principles. He chose an episode from the TV drama series Fringe which had a storyline on how an electromagnetic (EMP) pulse bomb was used to kill someone. He then sourced for information from a variety of school and library textbooks to give him a better understanding of how an EMP bomb worked and how it could kill a person. He pulled together all these different bits of information in a digital poster he created. His digital poster included a link to a video clip of the Fringe episode, self-drawn diagrams of an EMP bomb and the movement of electrons within the nervous system, equations and calculations. Table 2 (below) lists all the non-human actants he interacted with during the curricular program.

Table 2: Shen’s texts from the formal and informal domains

Formal Domain	Informal Domain
<ul style="list-style-type: none"> • Assignment task • Library physics textbook on electromagnetism • School physics textbook on the topic of solenoids • Biology textbook on how electrons are transmitted in our body • Books to support plausible values for strong magnetic field, flux density, and body velocity • Student-created glog/ digital poster to present his explanation and calculation 	<ul style="list-style-type: none"> • An episode of TV drama series Fringe which focuses on the use of an electromagnetic pulse bomb (EMP) to kill someone • Internet search on EMP bomb

We also examined the agentic moves he undertook as he navigated these texts to complete the task (see Figure 2). The first node (N1) was his assignment task. He connected his assignment task requirements with his experience of watching the sci-fi television drama, Fringe (N2), and then looked through the various episodes for one suited to his assignment. He decided on the episode involving the use of an electromagnetic pulse (EMP) bomb to kill a person and had access to the entire

episode (N3). He used this episode as a starting point for further interactions with a variety of texts to account for how the bomb worked and how it affected people. His initial search on the Internet (N4) for information on the EMP bomb yielded nothing substantial as, to the best of our knowledge, it has yet to be invented even though it is theoretically conceivable. As such, he went back to the basics to find out more electromagnetism (N5). He then turned to various school and library texts to explain how an EMP bomb could be made. He proposed using a solenoid to generate a magnetic field (N6) and conjectured how the electrons in the body could be affected by this electromagnetic field (N7). He also referred to some texts to generate some realistic numbers or measurements (N8) so that the bomb would have the intended effect of killing someone. All these texts represent additional resources from the formal domains which Shen brought into the network to support his efforts.

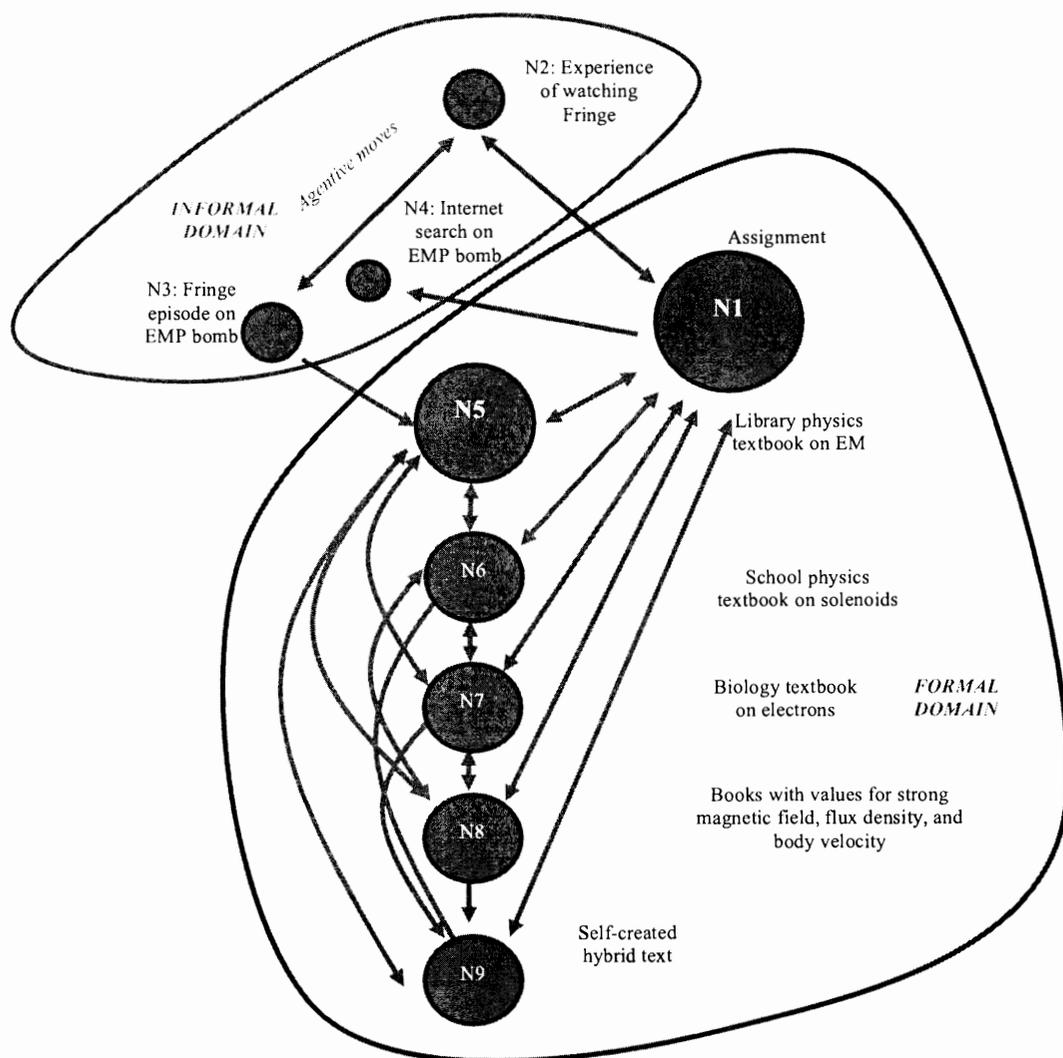


Figure 2: Shen's agentic moves across texts from the formal and informal domains

In navigating texts across the formal and informal different domains to complete his assignment, Shen's learning trajectory began and ended with texts (i.e. the assignment task and the self-created hybrid text) in the formal domain. The assignment task had

the most central role in his network. However, another text which also played a significant role was one he had brought into the network—the library book on electromagnetism. Once Shen had decided to focus on this topic, this book connected the Fringe episode and the assignment task as well as a variety of other texts from the formal domain. His understanding of electromagnetism was essential in his efforts to develop a plausible theory on how the EMP bomb might work. When Shen began accessing a variety of school and library textbooks (N5 - N8), he appeared to move from one text to another in a linear fashion. Each new text gave him further insights into how the bomb worked and how it would affect the body and also exposed gaps in his understanding. This then led him to source for further information in another text in order to develop a coherent and plausible explanation. However, we have used two-way arrows as he had to combine information from all these different texts to develop his digital poster and this required iterative movements to and from the different texts. The outcome was a self-created hybrid text (N9) with an excerpt of the Fringe episode and many self-drawn diagrams of electromagnetic waves in the bomb and the body and calculations geared towards helping his audience understand the plausibility of this phenomenon.

Our analysis highlights the different agentic moves adopted by high-achieving students to bridge formal and informal learning. Shen's agentic moves bore only a slight resemblance to Lucy's. The assignment task had a key role in both their networks. This assignment task catalysed interactions with texts from both the formal and informal domains and concluded with their creation of a self-created hybrid text. However, the differences between Lucy's and Shen's approach represented visually in Figures 1 and 2 are more telling in terms of the varied strategies employed to connect the formal and informal domains. The network diagrams illustrate differences in (i) the extensiveness of their network with respect to the formal and informal domains and (ii) the role played by their chosen media resource.

Lucy and Shen differed in terms of the extensiveness of the network relations they constructed with texts from the formal and informal domains to help them complete their assignment. Lucy's approach was far more typical of those adopted by the other students in the two studies. She applied physics concepts to a text chosen from the informal domain to explain the observed phenomenon (i.e. a colorguard toss) and turned to a couple of other texts and her own experience and understanding of the sport to help her complete this task. In contrast, Shen's approach was unusual in that he used the initial chosen text to generate a question for which there was no existing answer. This opened pathways to many other related physics and/or biology concepts and texts from the formal domain. As such, Shen turned to personal knowledge gleaned from one of his prior readings on electromagnetic waves within the formal domain and his interactions were mostly with academic texts.

This difference in the extensiveness of their networks is due to the role played by their chosen media resource. Lucy chose a hybridized text from the informal domain which had already been analysed by another student to help her apply the notion of force. The hybridised text facilitated her efforts at bridging her formal and informal learning. In contrast, Shen deliberately chose a media resource depicting a theoretically plausible phenomenon rather than an observed phenomenon. This opened up a space for exploration. It seeded an idea and got him to consider the plausibility of the phenomenon occurring in the real world. It gave him the room to generate his own

explanation. To do this, he had to search across several texts in different subject areas within the formal domain to enhance his understanding of electromagnetic waves before he could make any claims about the nature of the bomb and its impact on the human body.

5 Conclusions

Students need agency to be not just recipients, but also producers of disciplinary knowledge, developing a keen sense of the purposes of their practices and the needs of their audience as they engage in practices to demonstrate their own understanding of science concepts. Both these cases demonstrate students' agency in how they connected their learning across the formal and informal domains. Our network diagrams also illustrate the agentive moves students took in navigating different texts across these domains. These reflect variation in (i) the extensiveness of the network with respect to the formal and informal domains and (ii) the role played by their chosen media resource. Our analysis based on these network diagrams indicates that there is a need to move beyond the commonly held belief that agency is located within those who proactively engage in meaning-making to an examination of the effect of networked relations between people and/or objects. It also enables us to move beyond student selection of text as basic pedagogical strategy to understanding how students employ self-selected texts. In so doing, it highlights possible ways to intervene in these networked relations to facilitate adolescents' agentive moves in their learning endeavor.

Both interest and relevance are important components facilitating student agency in the learning of science. To do this, we need to encourage students to select popular media resource with which they are most familiar in order to fully draw on their understanding of how the resource can be analyzed to illustrate the application of physics concepts. However, student agency may be limited by a framework of choices concerning the languages, discourses, and texts to which one has access (Moje & Lewis, 2007; Purcell-Gates, 2007). Consequently, in some cases, teachers may need to give students greater exposure to using extant hybridized texts as a form of scaffolding as students initially engage in applying and explaining a physics concept in relation to an everyday phenomenon. Educators should also consider guiding students to select popular media texts which provide the opportunity not only to apply physics concepts to an observed phenomenon but also to conjecture about that which has not been observed. These need not necessarily reside in the realm of science fiction. For example, students could perhaps work out the size of an asteroid and its trajectory and crash site in order for this event to generate enough dust cloud to wipe out the dinosaurs.

In addition, it is important to acknowledge that students differ in their receptive and productive capacities with respect to academic literacies. As such, teachers may need to model the process of applying physics principles to everyday phenomenon in a way which is aligned with the preferred literacy practices of their students to facilitate the development of their receptive capacity. For example, they may choose resources with a lower prose density and which incorporate multimodal representations. Second, teachers may need to explicitly introduce physics literacy practices and transform their students' existing literacy practices to enhance their productive capacity. Such interventions would equip students with the necessary knowledge and skills for them to act agentively to support their engagement in a learning task.

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