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### *Modelling Nonlinear Information Behaviour: Transferability and Progression*

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# **Modelling Nonlinear Information Behaviour: Transferability and Progression**

## ***Abstract***

**Purpose:** This paper reports on a project aimed at moving Foster's Nonlinear Model of Information Seeking Behaviour forwards from an empirically based model focussed on one setting and towards one that is robustly transferable and enables testing of the model in other information seeking situations.

**Methodology:** The method utilised recoding of the original dataset, comparison of code decisions, and testing of the code book on a second dataset.

**Findings:** The results of the coding confirm the structure and interactions in version one of the model. The dynamic and nonlinear nature of information seeking is confirmed, as are the core processes and contextual dimensions of the original model with some extension and refinement of coding.

**Practical implications:** Changes to the model include new scales of extent and intensity, refinement of code descriptions, and extension of some elements to include multidisciplinary theories. Collectively these changes enable testing of the model in other information situations and opportunities for further research.

**Originality/value:** The results incorporate a number of enhancements that have been developed since the original Foster model was created; cognitive dimensions relating to personality and learning are enhanced and the codes essential to the revised Foster model are described along with a code book. The paper concludes by highlighting areas for further research.

**Article classification:** Research Paper

**Keywords:** behavioural model, information-seeking, development, coding practices, qualitative code book, secondary analysis

## ***Introduction***

Information behaviour is ubiquitous within the discipline of information science and there are many texts reviewing this area (Fisher, Erdelez & McKechnie, 2005; Case, 2007). Studies include behaviour within specific contexts (e.g. knitting circles, nursing) and many that focus on external factors such as environment, personality factors such as individual differences, and yet more that build complex models that relate search behaviour to information retrieval (for example Ingwersen, 1996). Major differences tend to originate at the epistemological level and permeate throughout these studies from the types of data collected and use of specialised terminology. It is notable that the end user ‘readership’ also triggers language differences such that discussions of information behaviour often have a focus on information users, information needs, or information sources, and beyond this of information foraging and information handling. Dervin & Reinhard (2006) usefully discussed this aspect with regard to user and audience studies. The problem of language as a barrier is most apparent where specialist studies touch on other fields, for example cognition and problem solving where there is sometimes a reticence to use the methods and language of those other fields of study. More fundamental is the tendency for models to be published but never developed further; yet as we look around different disciplines any model is merely a starting point for wider testing and refinement. One such model, Foster’s nonlinear model (Foster, 2003; Foster, 2004) offered a significantly different, nonlinear approach to modelling information seeking behaviour (see Figure 1 below); yet it too merely offered a starting point for further refinement and consideration.

[ INSERT FIGURE 1 HERE ]

[ INSERT TABLE 1 HERE ]

The initial work on Foster’s model (2004) has become a starting point for many new studies that are exploring information seeking, information literacy and information sharing, e.g. Tabak & Willson (2012). The project presented here aimed to further develop Foster’s model (2003; 2004) to more easily and robustly allow transferability of its coding to test other information situations. Though empirically based the original was derived from a single researcher and a single information situation. In working on Foster’s model the

authors recognise that the nature of information seeking behaviour to be complex and that we should be cautious in our interpretations of behaviour, in how we test them, and how we develop them where weaknesses are highlighted.

The project reported here aimed to test the original coding and themes of the model, generate a refined set of descriptive codes, and apply the agreed version of the coding to a second body of information seeking data. Subsidiary aims were to relate the model to cross-disciplinary bodies of research (and in this lay a foundation for a cross-disciplinary view of information behaviour). These aims were supported by the following objectives:

- Re-examine the assumptions in the original research setting by the researcher, and interviewees.
- Investigate the ‘reliability’ of the coding, and develop an agreed set of codes that enable other coders to act with confidence when applying the same set of codes.
- Validate the coding framework using a separate dataset to facilitate its use in analysing other information situations.

## ***Methodology***

Foster’s earlier study adopted methods from the tools suggested by Lincoln & Guba (1985) and Kuzel & Like (1991). There were weaknesses in the use of one coder, and one dataset. The study presented here adopted an approach to secondary analysis of two datasets and used multiple coders.

## **The datasets and secondary analysis**

The first dataset (coded D1 in this article, described in Foster 2003; 2004) was gathered 1999-2003 and was built from in-depth semi-structured interviews with academics and postgraduate researchers at the University of Sheffield. Interviews focused on information seeking experiences and the sample consisted of 45 participants drawn from the pure, applied, and medical sciences, the arts and humanities, social science and social science. The second dataset from the JUSTEIS project (coded as D2 in this article, details of the JUSTEIS Project are available at <http://www.dil.aber.ac.uk/dils/research/justeis/jisctop.htm>) was part of a longitudinal survey (1999-2004). It included a much larger sample of

interviews with 710 students in higher education and 513 students in further education drawn from multiple disciplines. Interviews in both datasets were fully transcribed.

Heaton (1998) has raised four issues for consideration before using secondary data analysis: compatibility, position of the secondary analyst, reporting of the secondary data, and ethical issues. In addition to these it is possible to add misinterpretation, and data quality. These are key concerns for any research but are emphasised with a secondary analysis. However, Medjedović's (2011) exploration suggests that these are not insurmountable concerns. Clear strategies are less clear in the literature but any strategy begins with researchers asking questions about the purpose of each dataset to ensure compatibility at a basic level (Stewart & Kamins, 1993) and thereafter seek to address Heaton's issues. In this project an essential first step for this project was the involvement of the original researchers to allow access to the data. This worked to overcome researcher detachment from the data and the risk of misrepresentation or misappropriation (Thorne, 1998, p.553; Dargentas & Le Roux, 2005).

A further limitation due to the different instruments and researchers used for each data set can be raised. However, both datasets have well documented research questions, interview schedules and worked towards clearly defined objectives. Furthermore, the datasets were based upon detailed interviews that held a very similar aim: that is to say the description of what the participants did to find information, how they performed the tasks, and what they thought about in moving through the process. Critical incident methods, vignettes and elicitation of classic descriptions of information seeking behaviour were present in the data collection for both projects. The ethics of the original studies were appropriate to secondary analysis, and the data from both datasets was cleaned of identifiers before being shared in the present project, again aided by the involvement of researchers from the separate earlier projects. Finally, although dataset D1 was fully utilised, it was undertaken originally by one researcher whereas in this second iteration it was subjected to multiple coders testing each coding action. Dataset D2 was analysed but with the aim of contributing to and interpreting quantitative survey analysis, there was therefore much more rich data available for analysis. Full transcriptions of interviews by experienced researchers permitted confidence in the quality of the data available in both datasets. Raw transcripts were also available without mark-up to ensure no problems of data structure, or influence from previous coding. Finally, dataset D2 also had the benefit of being an opportunity to test the transferability to a different

situation (that of inexperienced student information seekers), albeit still an academic related one.

## **Sampling**

A two stage sample based on a random draw of transcripts from the two datasets combined with data richness criterion applied to the initial draw. The aim of the sample was not to fully recode the datasets in full, but to sample sufficiently to achieve clarification of coding descriptions, and to code with these confirmed codes to achieve saturation point. A pilot was composed of 2 transcripts from D1, and 12 from D1 for the main recoding of the Foster dataset; the sample from dataset D2 was composed of 51 transcripts spanning undergraduate and master's level students, and a small selection of 5 PhD higher degree students.

## **Coding**

The coding method for this project was explored in some depth in Foster, Urquhart & Turner (2008) along with some initial results and will not be repeated here. From this earlier discussion issues of particular interest involved distinguishing between conceptual and detail level in the original Foster code book and the fact that coders may subconsciously adopt a smaller subset of codes in addition to issues of intertextuality (Kristeva, 1980) when reading interview transcripts. These were important as elements as the Foster study (2003; 2004) had a complex and strongly interpretivist multi-level coding framework. The method for the main study recognised the nature and form of the data as a product of naturalist inquiry. In coding exercises and confirmation of code meanings the present project emphasised an examination of the meaning, relationships, and categories working towards reinforcing the application of Lincoln and Guba's (1985, p.300) view of trustworthiness. Qualitative coders familiar with both data sets were used for the project. The coders for the project included the researcher responsible for the nonlinear model and original codebook and two researchers who had collected and analysed the JUSTEIS project data and researched information behaviour in various projects.

Two cycles of coding were deployed, each based on multiple iterations of coding by the team. In cycle (a) coding (*version 1.0*) focused on the original transcripts from Foster (2003; 2004). Team discussion of coding actions, interpretations and further clarification of coding processes allowed examination of the similarities and differences in the coding applied by the

team members to blocks of text. Coding differences arose as follows: as the result of an omission by one researcher of a code, as an oversight or judgement that the text did not warrant that attribution of meaning, and as one coder used a different set of codes to describe a phenomenon to those used by another researcher. The outcome of coding cycle (a) confirmed Foster's (2003) original interpretations while also allowing development of a refined set of codes that were then checked against another interview transcript from the original dataset. This coding introduced some referential adequacy that was not possible in the single-person coding of the original study (Lincoln & Guba, 1985, p.314). Coding cycle (b) then applied the agreed coding framework to analyse interviews from the JUSTEIS data sets, testing transferability. Within this cycle 22 transcripts were coded in depth over multiple iterations, while 29 were coded more briefly in fewer iterations of coding discussion as they were relatively briefer responses and coding agreements were fully achieved at an earlier iteration. Coding and memoing from cycle (b) formed the basis of a new code book and further development of Foster's model.

## **Results**

Foster's model was based around three core processes and three contextual elements, each composed of a set of activities. The following sections examine the core processes and contextual elements in the light of this coding project. Each section includes an overview of the codes, areas of change and stability, and indicative illustrations of the data supporting the analysis. The refined code book is available online at <http://cadair.aber.ac.uk/dspace/handle/2160/7695>. Codes names are capitalised and italicised and represent seeking behaviour throughout.

### **Components of core process ‘Opening’**

*Opening* described information-seeking activities focused on solving information problems, and is composed of *Chaining*, *Monitoring*, *Eclecticism*, *Keyword Searching*, *Networking*, *Serendipity*, *Browsing* and *Breadth Exploration*.

*Chaining.* Foster (2003) confirmed *Chaining* as previously described in other studies. Three elements were distinguishable: First, *Backward Chaining*, highlighted a pattern of behaviour for increasing the scope of searching and information available through the use of references, footnotes and bibliographies within items either already known to them, recommended to them, tangential to the area of interest or in the broad area. In a second form, *Forward Chaining*, or citation searching as it is also known, was perceived to be a much more focused and difficult activity. *Forward Chaining* involved two sub-processes: first identifying an author or paper of interest, and second, finding work that cited the original author or paper. The third form, *Source Chaining*, noted by Foster (2003) as an important stimulus to look at new sources and begin a chain of information seeking, reading and *Opening* far beyond the initial stimuli (e.g. an advert or a book). The recoding of the Foster dataset, and subsequent analysis of the JUSTEIS data revealed examples of *Chaining*, including some detailed responses to questions about how participants find information for a specific topic.

*Monitoring.* The relationship of sources to information seeking was continued in *Monitoring* activity which was defined as the activity of watching for change over a period of time. *Monitoring* was an important activity for the participants in Foster (2003) and was exhibited in activities including revisiting a journal, a website, or other source over a period of time. In recoding the original Foster dataset, and amongst the JUSTEIS PhD students, *Monitoring* was prominent, for example:

But the topic for my PhD needs continually updating, what new knowledge is becoming available so you need to keep yourself up-to-date. You need to look at the actual subject area but then there are branches of it and the whole PhD, as I go along, I think I must get more information on that or this person. (D2/PhD104101)

However, *Monitoring* activity required persistence and ongoing activity of this type was less prominent in the experience of undergraduate information seekers. This contrasts with the stimulus for *Monitoring* behaviour which clearly linked identifying a source to a probability of future “information drops” and some effort to pick up that information. Hence, current journals or recent periodicals gave a clear target for monitoring activity, while less obvious in the physical world was the use of various e-notifications, mailing lists, and publishers’ catalogues to maintain an awareness of new material.

*Eclecticism.* *Eclecticism* was identifiable in the recoding discussions as an approach visible in overview rather than at the level of lower level coding. The basic definition of a strategy over time that encompassed accepting, gathering and storing information from a diverse range of both passive and active sources replicated Foster (2003).

*Keyword Searching.* Unsurprisingly the application of keywords to searching an information source was prominent. Search results from keyword searching were viewed as valuable but sometimes ineffective when terminology was not fully appropriate or transferable across disciplines. In Foster (2003) *Keyword Searching* was quickly followed by more *Identifying Keywords* as the researcher became more absorbed in information searching and sometimes questioned their focus of interest. Indeed in the original coding, subsequent recoding of the Foster dataset and in the coding of the JUSTEIS dataset a clear relationship between '*Keyword Searching*' and '*Identifying Keywords*' was confirmed, as would logically be expected.

This is more interesting in looking towards a revised model as the results from the JUSTEIS data showed that the two activities were even more likely to be carried out almost simultaneously than had been observed with the original data set. Students were asked if they had modified their search and this was where the interplay between keyword searching and identifying keywords occurred, thus blurring the boundary between Foster's *Opening* and *Orientation*:

First of all, whenever I do a search, I try to get hold of the right combination. So initially I play with the words and search the parameters and thereupon once I've found those and I'm satisfied with the kind of findings that is coming, then I save that search. (D2/PG173104)

*Networking.* *Networking* was defined as a pattern of communication by information seekers via various media and with varying degrees of formality and structure to obtain information from other human contacts. It was found to be important for Foster's researchers (2003) and was confirmed as important to the students in the JUSTEIS dataset whose interview transcripts demonstrated networking as a source of keywords and sources as in these examples:

I didn't ask anyone professionally there to help me but I sat round and discussed with friends how they'd gone about different avenues they'd taken, bounced ideas about basically. (D2/166107)

....And so I just went on the Internet to find out if [X] version was better than the [Y] version cos [sic] I didn't believe it was. I went [to [website Z]... and I asked some people in a chat room there.... (D2/71107)

Overall, whether observed in novice seekers or experienced researchers, the two-way interaction of communicating with people (coded as *Networking*) was confirmed as a valuable behaviour from which much information was gained.

*Serendipity*. Foster's earlier approach to Serendipity Foster & Ford (2003) identified four sub-categories of serendipitous event within a framework that illustrated variations in user *Preconceptions and Knowledge*. As a concept for coding, *Serendipity* is challenging and it was by no means certain that an independent dataset would pick up the same aspects or that new coders would view the data in a similar way. Within the early stages of this recoding project there were some inconsistencies of coding approach arising from Foster & Ford's (2003) use of codes at both higher level "generic serendipity" and specific subcategories of serendipity. Where each coder used the available codes differently misunderstanding arose: sometimes coders were using a subcategory specifically, and at others using the more generic higher level identifier. Coding difficulties were clearest where transcripts indicated some serendipity but lacked sufficient detail to identify the subcategory of event. Overall for *Serendipity* dataset D2 held less descriptive answers, as in this quote from D2/166107.

...I found some more websites recently that would have helped quite a bit but that's through finding them when we were looking for other stuff really... It was just me happening on them. (D2/166107)

*Serendipity* was present; but the available data suggests student searchers are more accidental in their experience of *Serendipity* than the researchers in Foster (2003) who often had some knowledge of sources, defined problems, or an idea of the information gap that they were looking to fill.

*Browsing.* *Browsing* as defined by Foster (2003) was clustered in a broad approach to being with either Selective or Open. This was confirmed by recoding, though as the original Foster study acknowledged, there are multiple variations of the definition of browsing. The coding team agreed that *Browsing* should be more narrowly coded to increase coding reliability. To support narrow coding other frameworks of browsing were reviewed (e.g. Rice, McCreadie & Chang, 2001; Bates, 2007).

In the updated codebook a more detailed specification of the open and selective browsing was applied: *Open Browsing*, an activity oriented around viewing of information without a positive focus or guide as to direction, and is now specified with two variants: *O2-Open - poorly defined* (browse, graze, navigate, scan, glimpsing, examining); and *O3-Open - undefined* (encounter, serendipity, glimpsing). Informed by Bates (2007) this could be defined by an emphasis on glimpsing across different landscapes, selecting and making quick decisions on what to acquire and what to discard. A second form of *Browsing*, identified as Selective, implies a greater certainty about the routes that might possibly be used to find information. In Foster's model *Orientation* and *Consolidation* processes take account of selection and decision making, *Selective Browsing* is therefore defined as: *S2-Selective - well defined formal search and retrieval*; and *S3-Selective - semi-defined* (browse/forage/scan). Collectively the four sub groups of *Browsing* are consistent with work by Chang & Rice (1993), Choo (1998) and also Foster & Ford's (2003) Serendipity framework, as for example in these brief descriptions:

... I wouldn't say I'm good at using the Internet but I'm quite happy with using it...just messing about with it and playing around with it, you can find what you want by the end. (D2/85104) (*Open Browsing*)

...Let it search, see what comes up and just go through the articles, and see if there is any more information that I need.... (D2/173106) (*Selective Browsing*).

*Breadth Exploration.* *Breadth Exploration* was defined as a process where the information seeker consciously widens the scope of their information seeking (Foster, 2004). Consideration of the two datasets allowed refinements to coding that were suggestive of a scale ranging from high i.e. exploration of every possible piece of information, to low in

which just some pieces of information stand out as being immediately useful. The scale reflected the experience of the different interview groups: for interdisciplinary researchers information seeking tended towards an extreme based on an expansive strategy, while student information seekers tended towards brief narrow exploration aimed at highlighting shiny glittery items.

In Foster (2003) *Breadth Exploration* first approaches were common, and though sometimes described briefly were often accompanied by longer explanations of the follow-up activity. In the JUSTEIS dataset PhD students were found to act in a similar manner to the researchers and PhDs in Foster (2003) as in this quote:

I would probably do a general search, go for PubSearch first and I would probably also then, depending on what I got back from that, then trace back sources through that, looking at what I'd got, or I would go and look in a general encyclopaedia or something in the library. (D2/PhD104101)

Whereas the non-research undergraduate and postgraduate students tended more towards low exploration, for example D2/104106, yet some did perform a Breadth Exploration first approach as in the quote from D2/80101 where the focus was on breadth to identify keywords.

It (dissertation) is on e-commerce in supermarkets so I went to a search engine, Google, and put in ‘impact on e-commerce in supermarkets’ and it brought back loads of junk and you just have to pick out what you need. (D2/104106)

On the first search to find roughly what I needed I spend roughly twenty minutes to find it because I was thinking of all the keywords that could narrow it down more but on my second search I used words that were in the text that I’ve looked at before to see if I could find what I needed. (D2/80101)

### **Components of core process ‘Orientation’**

In Foster (2003; 2004) *Orientation* processes were defined as encompassing a diverse range of activities. Described simply, *Orientation* focuses on identification of questions and

directions to look and is composed of *Identifying Keywords*, *Picture Building*, *Defining a Problem*, and *Source Identifying and Source Selection Decisions*.

*Identifying Keywords.* The process of determining appropriate keywords to represent the topic of interest was important for participants in both data sets as part of search strategies; but it also highlighted some differences between the data sets. Keyword identification in the context of the original data set emphasised reflective consideration with keywords bridging the intellectual gap between existing knowledge and the unknown. In timing events the original dataset showed definitions of *Keyword Searching* to be associated with the core process of *Opening* and its attendant activity and one that depended upon identification of keywords before search as a thinking process, or via networking to ask for advice on keywords.

The JUSTEIS vignettes demonstrated limited reflectivity and activity, with a preference for obtaining keywords via *Breadth Exploration* with minimal reflection. In the JUSTEIS extracts, flipping between *Opening (Keyword Searching)* and *Orientation (Identifying Keywords; Refining; Picture Building)* was clearly allied to *Breadth Exploration* and *Networking Behaviour*:

First of all I'd sit down and brainstorm... and look [at] everything around it, then I would go on the Net. I would type in [keyword 1, keyword 2, keyword 3] and so on and see what that came up with. I would read that and then search again, see what you find read and build up on that...I'd use Google first...and look at academic sites... I think the key is to see what you've got, filter out the information you need and build on it and then use terms from there and you should build up enough sites to get a good picture. (D2/104106)

For the students in the JUSTEIS data sets the theme of sufficiency recurred throughout in contrast to the more motivated and determined researchers in the first dataset. The earlier version of Foster's model didn't fully represent the differences of approach by different groups. To enable measurement of the strength of engagement with keyword identification to be represented we propose a new scaled approach to behaviour recording *Extent* and *Intensity*.

*Picture Building.* *Picture Building* is defined as the way information seekers created an overview of a subject and constructed their understanding of what a subject was about: particularly its composition from sources, information, and questions. In coding and recoding of the Foster data set descriptions like this were of interest:

...I am much more likely to do it that way than get stuck into the details and actually discover that it is not so relevant. So I tend to be mapping out and seeing how it all fits together ...I am building the picture and at a later stage I will then get down to the details and pull in all the articles and read them in greater detail. (D1/P9)

The clearest and most graphic form of *Picture Building* process included a paper component for some interviewees on which ideas and reviewed material were sketched out containing words, concepts, sources, boxes, notes, arrows and lines linking the various components. In a similar way the creation of taxonomies aided the development of an understanding of shape and function of disciplinary components. This is compatible with other views of cognitive space models (Anderson, 1980; Johnson-Laird, 1983; Ingwersen, 1996, pp.37-41). In considering the JUSTEIS dataset student participants there are useful connections between these observations and the use of mind mapping to support search strategies in information literacy teaching (Brandt, 2001; Callison, 1997; McGregor, 1994).

The original process was observable and confirmed by recoding, but was less prominent in the coding of the JUSTEIS interviews. This was most apparent in the sub-codes related to the behaviour coded as *Identifying the Shape of Existing Research* which details what constitutes information, research data, methods, and perspectives were suggested to be important elements of Picture Building. Within *Picture Building*, the sub-code *Identifying Disciplinary Communities* was of central importance for D1 interviewees in their interdisciplinary information seeking; *Identifying Key Names* and *Identifying Key Articles* offered specificity in aspects of the area they were exploring; and timeliness of material was also identifiable with *Identifying Latest Opinion in Disciplines*. These elements were confirmed in the recoding of the first dataset, and were identifiable in dataset two as students' gave descriptions of finding information useful for their studies:

...a lecture a week, it's not really enough to get a broad picture of the subject and I think you need to get that, you need to have an overview of the subject before you can move

down to the details. It's better to have a structured overview than it is to have a head packed full of unrelated details that don't mean anything.... (D2/102105)

Foster (2003; 2004) recognised that the *Picture Building* process may be reduced by higher knowledge or other intervening factors such as existence of a social network or access to experts; that is to say it was variable subject to *Intrinsic Context*. This is supported by coding picture building events and by other studies that have considered how humans structure information, for example Vakkari & Hakala (2000) discuss the influence of “previous knowledge structures” in steering information need and information behaviour, while the idea of understanding information using pre-existing mental models is present in many places (Chen, Houston, Sewell & Schatz, 1998: 583; Heidorn, 1999; Hirtle & Heidorn, 1993; Marchionini & Schneiderman, 1988; Frost, 2001; Slone, 2002). Recoding also highlighted conceptual links with Linguistics: where *Picture Building* is discussed in terms of information seeking, Linguists perform an equivalent process of developing a macrostructure of understanding and coherence with a new language. Foster (2003; 2004) describes the process of developing and building the macrostructure and its interaction with *Knowledge*, and this also fits with the use of knowledge in the construction of linguistics macrostructures (Urquhart & Weir, 1998, p.252).

*Defining a problem.* The original code was named *Problem Definition*: the process of rationalising an area of interest and potentially broad information needs into a focus capable of consideration as an evolving objective for information seeking. However, an “area of interest” was present in many of the descriptions given by interviewees and provided the stimulus for further enhancement and focus. The new coding iterations and discussions focussed on better distinguishing between the definition process and the definition as outcome. Examination pointed to a better label for the code as *Defining a Problem*, and suggested that as a process it was more accurately described by a variable scale than an absolute binary variable. The second data set was useful in highlighting key elements of the (renamed) *Defining a Problem* process. Recoding and coding suggested that the researchers in the original data set were able to view their defining process and to consider their topic in a wider sense; while dataset D2 was more suggestive of defining a problem in the immediate and narrow form of the search episode. The differences point to the importance of the

context surrounding information problems, and particularly seeker experience, motivation and where the task fits into a wider role.

*Source Identifying and Source Selection Decisions.* *Source Identifying* was defined as the process of identifying potentially useful sources of information the original study found close links between *Opening* activities and *Source Identification*. This was particularly so for the activities of *Networking*, *Chaining*, *Serendipity*, and *Browsing* and these formed the most significant tools from which source identification developed. The source identifying and selecting processes from Foster (2003; 2004) were confirmed. For example:

[I]... considered it in terms of which website it is and normally prefer ... whenever I hit upon a new website, I just try to have a look at the background and how reliable it might be, whether it is a research body or an academic body or a professional body...such factors vary. (D2/PG173104)

*Source Selection* is suggested by this to be based on multiple criteria: need, quality, and contextual aspects such as accessibility: it is both simple and complex, as also implied by Hjørland (2011).

### **Components of core process ‘Consolidation’**

Foster’s earlier definition of *Consolidation* as a process of judging, integrating, and deciding whether further information seeking was necessary was confirmed across the original, and new data sets. *Consolidation* was composed of *Knowing Enough*, *Refining*, *Sifting* and *Reviewing*, *Relevance Criteria*, *Incorporation*, *Finishing* and *Verifying*.

*Knowing Enough.* In Foster (2003) ‘*Knowing Enough*’ was a reflective process assessing progress towards a goal; it was matched with ideas of sufficiency and information need. Examination of *Knowing Enough* revealed some differences between the datasets. For students in the dataset D2 the emphasis was much more simply defined as satisfying by gaining enough information to meet immediate needs rather than on satiating parts of an ongoing need. Descriptions such as the following were typical:

Oh well, I found things I had to write about....But I think I found reasonable enough information to go on with the essay... (D2/71111).

Taking account of this variation the revised model represents the idea of a minimum or acceptable level of information as being highly variable between different cohorts of information seeker. There was a particularly strong connection in the dataset D2 with time as a limiting factor and this is discussed below.

*Sifting and Refining.* The application of *Relevance Judgements* is an interaction between information and information seeker. The methods associated with *Sifting* behaviour were in themselves basic: it relied upon an information seeker considering the available information and applying a relevance judgment to it. In the original research study, *Sifting* was the process of applying *Relevance Criteria* and was described as the *application of relevance judgements*. There is a strong similarity found with JUSTEIS dataset descriptions:

Um, probably about half an hour or thereabouts so far, the big issue is always once you've got the great long list of hits, you've then got to trawl through and actually find out what's useful and what isn't. (D2/PG173102)

*Refining* was confirmed as a process of deciding on search boundaries and narrowing the search focus and is distinct from *Sifting* as *Refining* moves from using to creating relevance criteria:

Oh all the time because one particular subject, as you know, is greater than what it looks. It's more in-depth, so it threw up so many latest research or studies or just general work that had been written in this particular area but they may not be significant. So you need to narrow it down further and further or maybe add a concept, for instance 'clinical supervision', 'professional development', 'professional growth', 'requirements for further education' and that's how I would go on, that's how I would narrow it down. (D2/104101)

In Foster's model, the activities of *Sifting* and *Refining* were to be found in the *Consolidation* core process as part of the movement between processes. Recoding and application to the JUSTEIS data confirmed the presence of *Sifting* and *Refining* and that this

was a continual all permeating process. *Sifting* and *Refining* codes were found in the JUSTEIS interviews, usually described concurrently with *Opening* and Orientation core processes and echoed the tendency for less reflection amongst undergraduate students. The behaviour was closely related to the researcher's previous knowledge, and perceived expectations such as problem definition.

*Reviewing.* Foster's (2003; 2004) study identified something of a pause in information seeking and that this was used by participants to assemble the information they had gathered or previously known to current information problems. This behaviour was associated primarily with assessing prior knowledge, the use of personal collections, and in subsequent iterations of reviewing with information already gathered, and in a "physical" parallel of information organisation e.g. generation of bibliographies from previously collected material and personal collections, for others the idea of drawing out the ideas, questions and pieces of information provided a similar effect.

The choice of subsequent seeking activity was obtained from *Reviewing*: *Reviewing* led to seeds of information that could be developed further with information seeking. *Reviewing* particularly contributed new inputs to *Picture Building* (which is part of the Orientation core process). In dataset one a *Reviewing* pause was well defined; however an alternative pattern was revealed for the dataset two as student information seekers reduced *Reviewing* to a less defined state of briefly looking at results. In the JUSTEIS dataset a much more superficial *Reviewing* process was found compared with that of the researchers in the original study, and the descriptions from undergraduates were often far briefer and focused on the outcome.

Yeah, well when I did my initial first search I just typed 'real audio' so that brought up hundreds of thousands but then when I read through the different things, you just pick up different words and you put them into the search and then it brings things you want up in detail, so I did refine my search many times. (D2/104103)

Swift movement through the processes was clearly adequate for their immediate purposes; but was also suggestive of different levels of information literacy and of information seeking context. The JUSTEIS dataset PhD students exhibited a longer and more distinct pause for reflective consolidation, in line with the original dataset researchers. Examination of

reviewing behaviour suggests a scale to reflect difference in both extent and intensity of reviewing activity.

*Incorporation, Finishing and Verifying.* Three codes, *Incorporation*, *Finishing*, and *Verifying* that were prominent in the original research were found to be lower priority tasks for the JUSTEIS student participants. The datasets describe the incorporation of material into their understanding as ‘taking on board’, ‘trying to tie them all in’, ‘bringing it together’: we might tentatively refer to this as learning. *Incorporation* was recurrent throughout information seeking as a process associated with drawing together. Incorporation was most evident as a process of merging new material into the body of material and knowledge already held. As a periodic process *Incorporation* was something that occurred most often during and after exposure to information. *Finishing* included final information seeking to update earlier searches and to ensure a measure of completeness was achieved. Interviewees described one other process identified as *Finishing*, composed of activities as diverse as browsing, keyword searching and networking, this process was described as “sweeping up” the loose ends before closure. Interviewees explained the process of closure in relation to *Knowing Enough* and *External Context* and pointed out that the context in which they worked set deadlines and practical limits. These gave more of an impulse towards forced completion, rather than a sense of reaching a point of natural completion as a termination of information seeking. Once again students are distinctively task and deadline driven, whereas researchers often have a longer term goals as highlighted in Nicholas, Rowlands, Clark & Williams (2011). Within the original group of participants *Verifying* was defined as checking the accuracy and completeness of information. In this few surprises were anticipated (Ellis & Haughan, 1997). Examples from Foster (2003) suggested that even when working in a novel subject area information seeking tended to incorporate measures to confirm the accuracy and worth of the information found. The JUSTEIS dataset highlighted students at lower levels of behaviour moving from ‘relatively little’ to ‘none’. However, the PhD students included within the JUSTEIS cohort were following process identified in Foster (2003) and earlier studies:

...actually I needed a small clarification on that as well but I eventually had to go through papers written by this woman, and I ended up having to do sort of quite in-depth stuff to

find out what I wanted...and I'm still going to have to find out some more because I still haven't finished the job. (D2/PhD169107)

From the two streams of data analysis it is possible to view *Verifying* as highly suitable to a scale approach, ranging from a basic process through to complex source triangulation level.

## Intrinsic Context

The coding of the datasets considered the evidence of *Internal* and *External* contextual factors, as well as *Cognitive Approach* as described in Foster (2004). The JUSTEIS student interviews asked about priorities, and students' feelings about the success of the search. Often comments revealed a desire for immediate gratification and for completing a search as quickly as possible, with as near a match as possible with requirements. Difficulties in searching were associated with the problems of obtaining results that were specific enough. An open approach to finding information amongst the JUSTEIS students was often allied to a strategic approach that quickly gets to information deemed useful:

I have just done one on banks and telecommunications and I've been looking at sites like that ...because they sometimes give you a lead of where else to go as well. ..I speak to other students that are also doing it, to see whether they have got good sites, we kind of share our resources. (D2/PG74112)

Consideration of these themes leads towards a more fully developed set of scales relating to learning, personality and affect. Coding discussions revealed that some of the differences in recoding and the coding of the JUSTEIS dataset were due to the differences in opinion on the scale of a particular phenomenon. The data supported the original coding, but the terminology required standardisation and extension. In this revised view the groups of codes for *Internal Context* and *Cognitive Approach* are combined as *Intrinsic Context*. This new category represents a group of variables expressing aspects of ways of thinking, experiencing, and interacting with information problems. Specific coding changes address the role of motivation, learning styles, and personality on behaviour, whereas the initial model transparently assumed the presence of *Motivation* and focused on observed patterns.

*Personality and learning.* In the original coding *Flexible and Adaptable* behaviour was reflected in both *Nomadic* behaviour and exhibition of openness. In the amended coding *Flexible and Adaptable* behaviour are viewed as part of *Personality and Learning* codes. In simplifying and developing this aspect the revised view incorporates the body of literature on (a) *Personality Traits* and (b) *Learning Styles*.

Norman (1963) developed the study of personality traits with several scale dimensions that include extroversion, agreeableness, conscientiousness, neuroticism, and openness to experience which suggest a line of further development. Openness to experience has scales for intellectual versus unreflective, narrow and imaginative versus simple, direct. The personality traits of conscientiousness and openness might be useful in helping in classify differences in individuals' information seeking behaviour. Within conscientiousness there is a scale (persevering to quitting/fickle) and the openness as described in Foster (2004) relates openness to experience. As with all personality identification caution is necessary (Gleitman, Fridlund & Reisberg, 1999, p.695; Snyder, 1987).

The Foster dataset interviewees held a view of their work as *Holistic* and based around gaining and keeping a “big picture” and described this as a way of thinking and structuring their approach. Interviewees suggested that they aimed to gain a Holistic understanding through information seeking from which they could develop their own research themes. This has a parallel in the JUSTEIS data and the literature of learning styles. The code term *Holistic* can be related readily to holistic learning styles. There are several categorisations of learning style that relate to learning through reading (Urquhart & Weir, 1998, p.99): holistic versus serialist (Pask, 1976); deep processors versus surface processors (Marton & Säljo, 1976); logocentric versus resistant (Hartman, 1992) and dominant versus submissive (Widdowson, 1984). In reviewing the original data there are apparent similarities between the holistic processors and deep processors and between resistant and dominant approaches. Further clarification may be offered by Heinstrom (2005) as three student searching styles integrating aspects of different cognitive approaches (learning styles) with personality traits to fit the data: Fast surfing is related to a surface study approach that has low openness to experience. Broad scanning was linked to openness, extraversion and competitiveness. Deep diving is characteristic of an analytic approach, with deep or strategic approaches to learning. In assessing the optimum ways to measure these attributes it seems likely that multiple measurements drawing on those above would be beneficial.

*Knowledge.* The link with learning is continued with *Knowledge*. *Knowledge* appears as the result of a process of establishing a scheme that makes sense of various bits of information can be new or existing (previous knowledge). The link with *Picture Building* (discussed above) is well defined here. *Knowledge* within the datasets contributes heavily to *Picture building* and *Reviewing* as a framework or scaffolding to support coherence, organisation and understanding of a topic.

*Affect.* In recoding and repositioning affective elements feelings and emotion were confirmed as having an impact upon the willingness to undertake certain tasks and the type of outcome obtained. The literature supports the view that the more positive the affect the likelier it is that people are to undertake tasks and are able to categorise material more flexibly (Isen, Daubman, & Nowicki, 1987; Estrada, Isen & Young, 1997; Isen 2009). If we relate cognition to affect, it is possible to consider successful *Nomadic Thought* behaviour as originally identified in Foster (2003; 2004) as the result of a particular learning style (logocentric or submissive) allied to positive affect. The concepts of positive or negative affect, and schema theory or the subcase of schema of scripts (characteristic sequence of events in a particular setting) are also of potential interest in measuring these aspects (Bartlett, 1932; Schank & Abelsen, 1977).

Further understanding of affective aspects identifies *Feelings and Thoughts* along with *Self-efficacy*, *Feelings of Uncertainty*, and *Perception of Topic Complexity*. Significant scope for the definition and measurement of *Self-Efficacy*, *Uncertainty*, and *Perception of Topic Complexity* are found in the work of Kuhlthau (1991; 1993) and Wilson et al (2002).

*Motivation.* Omitted from *Internal Context* in the original Foster model, *Motivation* occurs as a significant factor in studies of comprehension patterns of information need (Entwistle, 1987; Toms, 1999; Urquhart & Rowley, 2007). *Motivation* was included as part of the implicit normal framework for the subjects of the original study. In the JUSTEIS dataset *Motivation* was revealed as a significant variable: the reason or drive for an activity. Early work by Fransson (1977; 1984) linked motivation, learning approach, and outcomes with regard to reading. Fransson found students who were motivated by expected test demands to read a text for which they have little interest (extrinsic motivation) were likely to adopt a surface learning strategy. Students motivated by the relevance of the content of the text to their personal needs and interests (intrinsic motivation) adopt a deep level learning approach.

The sample in the original Foster (2003) study were all highly motivated researchers, and as such offered little opportunity to uncover extrinsic motivation as a significant factor. The JUSTEIS dataset tended to highlight extrinsic motivations and an immediate outcome:

I wanted to look for the formula for standard deviation because I'd forgotten it and then so I typed 'standard deviation formula' into Google. It came up with several sites and the first one I clicked on, it had the formula there. (D2/169105)

*Motivation* was therefore included in the revised view of *Intrinsic Context* to fully express this feature of information behaviour enabling transferability of the model across multiple groups of information seekers.

## **Extrinsic Context**

*Extrinsic Context* as an element of the model emphasises that an information seeker is not isolated from the multiple factors surrounding their information seeking. *External Context*, now renamed *Extrinsic Context* for consistency, was highlighted in the two different datasets and allowed confirmation and extension of the original Foster (2003) approach and descriptions. Social Environment opportunities for networking and interaction were stressed in the earlier study of interdisciplinary researchers and confirmed for the JUSTEIS dataset. Reliance on goodwill and informal sharing was on par with good formal resources in the perception of participants. *Time* and *Project* elements frame the resolution of the information problems in both student and researcher contexts. Major variants observed across the datasets were simple well defined tasks versus open ended longer tasks. Time as a resource was a considerable focus for the student participants in the JUSTEIS data set:

Well, I would have given it a 5 (score out of 5) if uhm...if the information had been given in the way I wanted it. (D2/104106)

*Time* also shaped activity and decisions as to sources, depth, and coverage and what as knowing enough: for the JUSTEIS dataset instantly accessible items were more attractive.

Codes for *Navigation Issues* and *Access to Sources* referred specifically to the organisation of information and access technologies and to the problems incurred by information seekers as they move from familiar territory towards new information environments. In both datasets *Access to Sources* was bound to both physical and resource aspects and made a substantial contribution to *Source Selection Decisions* and the *Context of Source Selection*. *Physical Access* was defined by interviewees as being able to look at, and use, a *Source*, in this sense it is very much a matter of geographical (or virtual) location relative to the information seeker. For behaviour such as *Browsing*, ease of access was vital to use of *Sources*, and where material was accessible only with a resource element of either a time delay or expense then it was judged inaccessible:

...in my case access was the ultimate thing because I had very limited resources anyway.  
(D1/ P1)

Resources that were not easily available, unless they were proven to be very valuable, were ranked lower by interviewees and alternatives sought. Physical location and resource access appeared in a continuum from a source that was available with some exertion of effort locally through to something being entirely inaccessible or unobtainable.

### ***The relationship of processes and the revised model***

In Foster (2003; 2004) the interaction between processes operating in a complex web of transactions, responses, and influences was challenging to some simpler views of information behaviour. The analysis performed in the present project has confirmed each of the core processes, with some refinement of the coding of component behaviour. There is evidence that information seekers are flipping between the processes, and that there is variation in the patterns observed based upon interactions between the product of each process, and of intrinsic and extrinsic influences. It was especially useful to have PhD students within both datasets alongside the Undergraduate students, Master's students and academic researchers.

There is non-linearity and complexity as in Foster's original definitions, but these are best interpreted with the incorporation of two additional scale parameters: *Extent* and *Intensity* as illustrated in Figure 2, with *Extent* recording span or duration of activity and *Intensity* recording a superficial through to intense activity on each element.

[ INSERT FIGURE 2 HERE ]

This was particularly highlighted with the undergraduate student descriptions of search strategies that were far briefer and focused on the required outcome, moving swiftly from *Opening* to *Consolidation* with little evidence of *Orientation* as a process that takes time. The revised model is represented in Figure 3 below.

[ INSERT FIGURE 3 HERE ]

The combined effect of the changes is an incrementally enhanced, more transferable model of behaviour rather than a radical departure.

## **Conclusion**

The results presented here move the study of information behaviour forward incrementally and cautiously:

- The core processes of *Orientation*, *Opening*, and *Consolidation* were confirmed, while the representation of *Context* and *Cognitive Approach* (Foster, 2003) were reformed as *Intrinsic Context* and *Extrinsic Context*. The model and the coding have been successfully transferred to additional information situation via analysis of a new dataset. In particular it is possible to use the revised model to make sense of the behaviour of full-time academic researchers, academic related researchers, PhD students and the very different group, undergraduate students. Beyond these groups further work would be necessary.
- The variables originally coded by Foster (2003) are developed further with reference to a broader multidiscipline literature. The definitions present in the revised codebook are workable and reduce the scope for inconsistency in their application in other situations. The research highlights that information behaviour is scalable, and that different groups do more of some behaviour, and less of others, while still fitting an overall model of behaviour. Accordingly scalability of the *Extent* and *Intensity* of activity at lower and higher levels is now incorporated into the revised model. Though the purpose of this study was not to explain student

information seeking, the ideas represented here have potential to assist in further exploration and mapping of such behaviour, possibly with reference to current practices and teasing out further detail of complex interactions.

Questions arising from this study suggest some aspects for further investigation and development:

- The speed of transition from one core process component to another was not measured, but is indicated to vary significantly. How quickly do the processes occur?
- Specifying questions relating to the developing Extent and Intensity scales proposed here and more fully developing the relationship with the personality and cognitive aspects in this paper. The different *Extent* of the *Consolidation* process in each of the datasets suggests a possible focus with which to further examine our ideas of information literate behaviour, and reaction to search innovations.
- It would also be valuable to follow up the scales describing both *Personality Traits* and *Learning Styles*. The revised code book points to the scales and literature that will offer others scope for developing these themes. Some related work at doctoral level (Stokes & Urquhart, 2011) highlights some potential avenues for development and further empirical study to bring them fully within the scope of the model.

The complex variables present in information seeking behaviour again leave us with new questions to consider, and the implications of the work put forward here should to be fully explored in the light of new information situations and new groups of information seekers.

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#### INSERTS FOR FIGURES AND TABLES

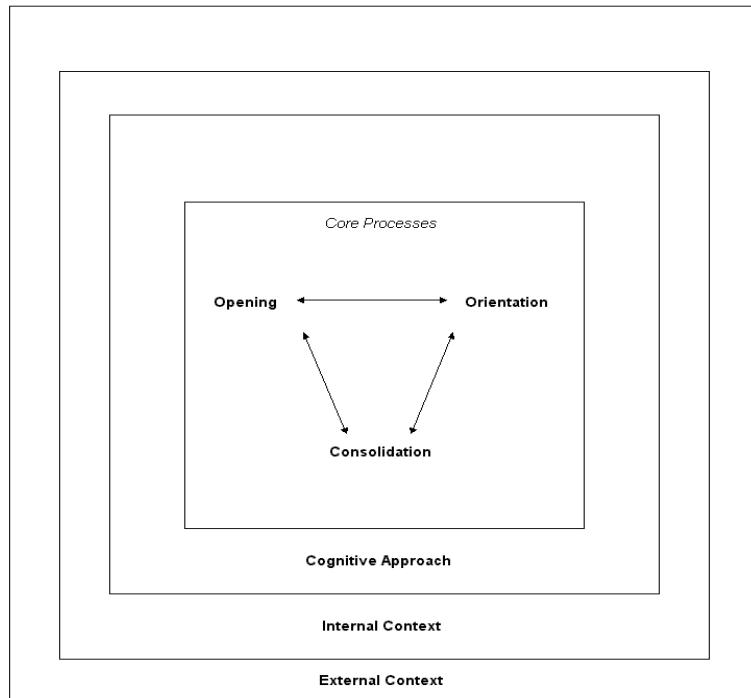


Figure 1: Nonlinear Model of information seeking-behavior, (Foster, A. (2004 p.232).

<i>Orientation</i>	<i>Opening</i>	<i>Consolidation</i>	<i>Internal Context</i>	<i>External Context</i>	<i>Cognitive Approach</i>
Reviewing	Breadth Exploration	Refining	Knowledge and Understanding	Time	Flexible
Picture Building	Eclecticism	Sifting	Feelings and Thoughts	Project	Adaptable
Identify Keywords	Networking	Incorporation	Coherence	Navigation	Open and Opening
Source Identification	Keyword Searching	Verifying		Social	Nomadic Thought
Source Selection	Browsing	Finishing		Organisational	Holistic
Problem Definition	Monitoring	Knowing Enough		Access	
Identifying the shape of existing research	Chaining				
	Serendipity				

Table 1: Core processes and main component activities of Foster's Nonlinear Model (2004) adapted from Foster, A. (2004, p.232)

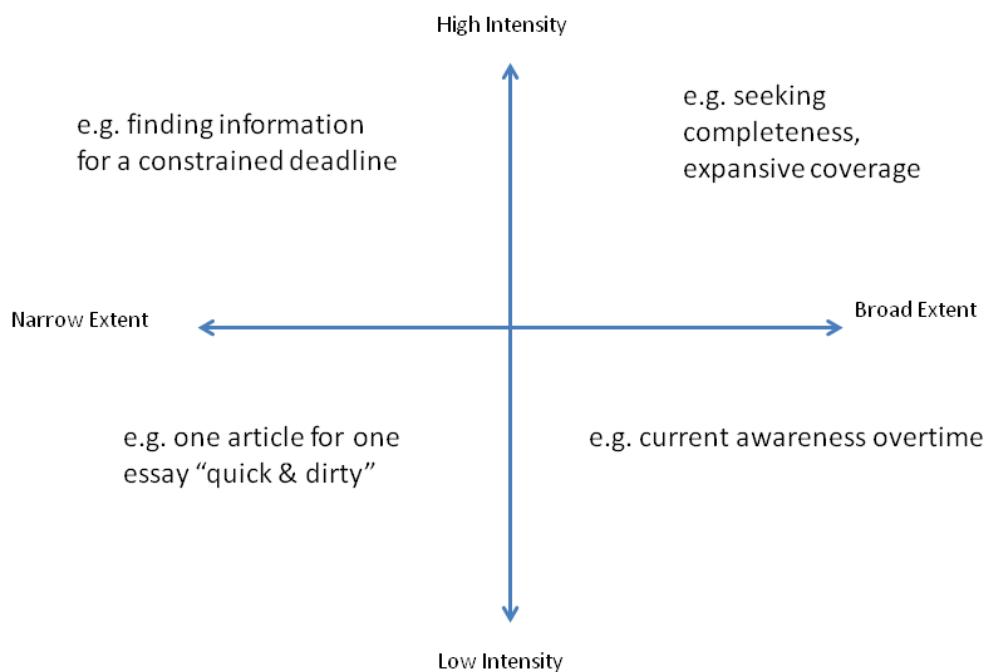


Figure 2. Envisaging scales of Extent and Intensity

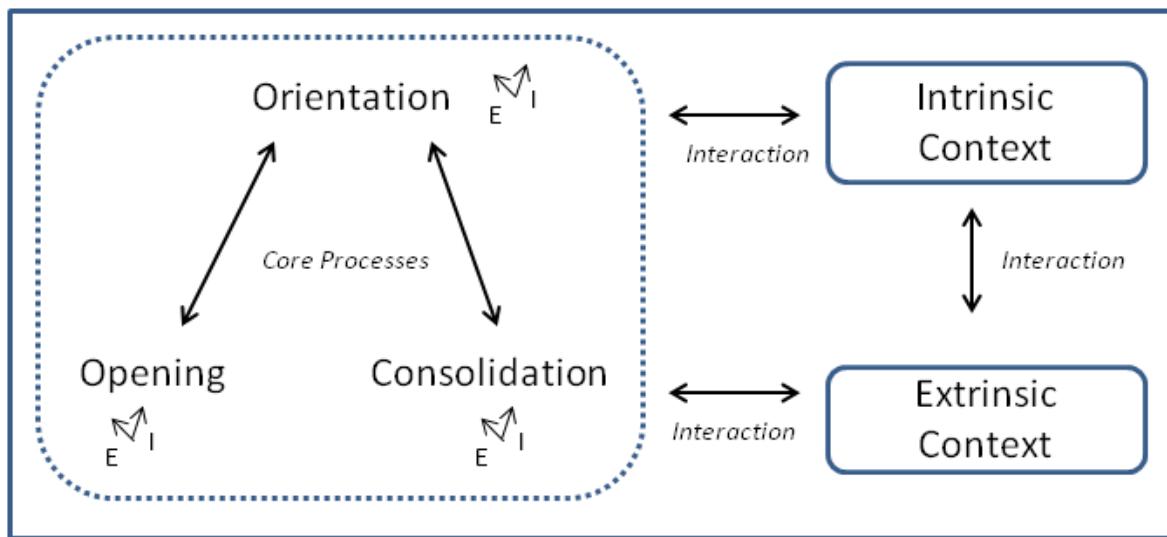


Figure 3. The Foster Nonlinear Model, a revised top level view.