A Connectivist View of a Research Methodology Semantic Wiki

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Abstract. The use of virtual learning spaces for learning and teaching needs to be underpinned by a pedagogy that provides a basis for the approach used. Connectivism takes a networked view of knowledge, and its characteristics and understanding of learning were investigated. The development and structure of a research methodology semantic wiki were described, including how the semantics present in the wiki allowed for the exploration of the structure of a research methodology. Positive student evaluation of the wiki led to examining it from a connectivist point of view – how connectivisms nodal and networked structure could be identified in the wiki and how learning could be understood in terms of the activities and levels of interactions in connectivist learning.

Keywords: Connectivism · Semantic wiki · Research methodology

1 Introduction

Virtual learning spaces must be implemented in terms of a pedagogy that informs the use of such online approaches [1]. While it has been argued that there is no single learning theory that can be used to understand online learning [2], it has been suggested that current learning environment development is driven by technological advances rather than a considered pedagogy [3]. Thus, the drive to use alternative, often online, approaches to face-to-face modes of delivery of learning and teaching [4] needs to be achieved within a framework that is pedagogically sound. This would be true, too, of the research education that accompanies postgraduate research supervision.

Understanding research methodology is fundamental to good research and developing competent researchers [5]. However, the research methodology domain is widely believed to be difficult to learn in that it is both conceptually complex and technical [6], leading to students having difficulty dealing with the diversity of conceptions of the domain, with little consistent understanding of the constructs involved – where there is “a lack of shared language describing important foundational concepts of research methodology" [5, p. 230]. Students are frequently concerned about the difficulties associated with research methodology and typically bring misconceptions about the domain into their studies [7], leading to calls for clearer and more concrete distinctions to be made between the various constructs that make up a research methodology, as well as an understanding of the relationships between them [8]. Blended approaches that extend research education to online tools are being used to support this learning [7, 9].

Advances in technology have led to alternative forms of presenting research methodology education, including web-based approaches [10]. It has also been noted that the growth in participatory technologies and Web 2.0, in which much of current social media is situated, has altered the environment in which interaction is enabled, information is accessed, and knowledge is created, allowing anyone to connect and share with others in the creation (and publishing) of this knowledge [11]. Online environments used for teaching and learning purposes have moved past institutional learning management systems to virtual communities of practice [12], where little is done in isolation, and are characterised by more social and collaborative models of learning [1]. Here, students are immersed in situated networks of social relationships of learning and shared practice with supervisors, other academics, and peers [13, 2]. However, such virtual communities are still in their beginning phases, and the role that Web 2.0 technologies play in these virtual communities in terms of learning still needs to be explored further [12].

The Semantic Web is one area where knowledge representation and integration with e-learning can have an impact on higher education [14]. Semantic web technologies support linking data using semantics, which help provide meaning to the link, and so supersede the basic linking that Web 2.0 provides [15]. Combining semantic web technologies with learning theory and teaching and learning practice is producing interesting results, although it is still at an early stage of exploration [14]. Interestingly, the Semantic Web is not yet recognised by the NMC Horizon Report [16] as one of the enabling technologies that will transform what can be expected of online tools in higher education.

Recognising the role that the Semantic Web can play in knowledge representation, and the necessity for researchers to master research methodologies, the question explored here is to appreciate to what extent a learning framework provided by connectivism can be used to understand the use of the affordances provided by semantic technologies in the learning of research methodology structure by postgraduate students.

An understanding of connectivism as a learning model will be presented first, followed by the description of a semantic wiki employed to explore research methodology structure. The connections between the two, showing how a semantic wiki can be seen as an implementation of connectivist approaches to learning, will be discussed. Finally, some conclusions will be offered.

2 Connectivism

The learning environment has changed in the last 15 years, and knowledge is no longer seen as immutable (something that can be learnt once and is known or mastered forever), but is now seen as the ability to find and create knowledge rather than simply consume it [11]. Knowledge and learner management solutions have often failed as a result of the heavy dependence on content and/or technology [17], whereas a connectivist approach leads to a shift away from knowing *what* to knowing *how* or *who* and even *where* [18]. Connectivism, then, recognises that the ways in which knowledge flows have changed substantially as a result of the data communication networks that have become available [2].

2.1 Understanding Connectivism

There has been a move from more behaviourist and cognitivist theories of learning, through constructivist and social constructivist theories, to Siemens's connectivist theory of learning [11, 18, 19]. It is an approach that is not built on past learning theories [20], although connectivism was influenced by social constructivism and the growth of technologies that allowed online participation and collaboration [11]; it may be characterised as networked social learning [21]. It must be noted that there is some disagreement about whether connectivism is a theory of learning, or a pedagogy and model of learning [20, 21]. However, here connectivism will be used as a conceptual framework in which to understand a semantic wiki approach, as it is believed that it is a valuable contribution to the ideas of learning within a technologically connected (and networked) world [21].

Connectivism considers knowledge to have a distributed structure [13]; that is, knowledge can be seen as a network with nodes, with a node being any object that can be connected into a network of some sort [20], and the most effective and reliable way of accessing knowledge is via these networks [22, 15]. These nodes can be understood at different levels, from the lowest (the neural network in the brain), to the conceptual or internal (the thoughts and ideas that humans use to interpret the world), to the external (which can be made up of a range of node types and information sources, including people, books, websites, programs, and databases) [23].

These nodes are then linked by interactive relationships, where this link may have direction, may have an inverse link, and may even connect back to the node itself [20]. Concepts then grow by connecting to other concepts [20], where a group of connections seen as a whole is known as a pattern [23] that holds meaning. This pattern may itself be considered a node, so that a node may contain a network of its own, where the node is made up additional nodes [20]. Connectivism holds that such composite, pattern nodes are greater than the sum of their constituent parts [20]. Although knowledge is conceived of as having structure, this structure is not necessarily well organised, is complex, may be chaotic, and does not have layers or a hierarchy; furthermore, the relationships between nodes can be active or inactive [23]. This implies that, as concepts connect to other concepts, the link strength may vary from person to person, leading to different ideas, and meaning, in knowledge networks [20].

The role of technology is emphasised differently by various authors [23], although it has been argued that it can play a role both as actor (such as an artificial intelligence agent on the Semantic Web) and connector (the Internet itself) [20]. Certainly, it is these digital information and communication technologies that allow students to follow links in the process of exploring new information [15]; it is the connector that allows node relationships to current information to be built more easily [20].

2.2 Connectivist Learning

Downes argues that "[k]nowledge is embedded in [the] mesh of connections, and therefore, through interaction with the network, the learner can acquire the knowledge" [22, p. 8]. Learning is, thus, a process of network formation and pattern recognition and acquisition, distributed across a social network of connections [24], and what students can reach in the knowledge network while exploring, and finding patterns, is considered learning [20]. Also then, better connections lead to better flow of information [23]. Learning is, therefore, not acquired (and one cannot rely solely on what an individual knows to make good decisions). Rather, knowledge is "knowledge *of* the interaction" [13, p. 78, italics in original] between entities, and learning is the ability to access and navigate these knowledge networks, seeing and building connections between concepts and finding and evaluating information [15] – learning as "actionable knowledge" [18, p. 4]. Thus, connectivist approaches, which focus on connections rather than frequently changing current content, allow for rapid changes in both learning context and content [15]. As Siemens notes: "The pipe is more important than the content within the pipe" [18, p. 5], and knowing where to find updated information is more valuable than remembering its current state [15]. Additionally, in this approach, the student becomes a member of a learning network and is a node, too, that can connect with other students/nodes [23], leading to collaborative approaches to learning.

Siemens [18] points out that connectivism also has implications for the design of learning environments, and instead of a content push design, there needs to be an acknowledgement of the contribution connectivism makes to learning theory – hence the need for new models that reflect this approach to learning and knowledge [17]. Concepts should be seen as forming a network rather than simply being linear [21].

It is worth remembering that "[c]onnective knowledge is no magic pill, no simple route to reliability" [13, p. 100]; it remains one approach to knowledge that can be used to examine learning and teaching practice. Furthermore, connectivism is not without its critics [23, 19]. The argument is that, with the focus on what constitutes learning in a connected world, there is no clear account of how connections are made and how learning is achieved. Additionally, it is not really anything new, and current theories (behaviourism, cognitivism, and constructivism) are sufficient to deal with technology in learning. There are also concerns that it is not testable and that it underplays human interaction.

2.3 Research Methodology Education

Thus, a focus on research methodology education is more than simply a matter of providing a postgraduate student with online resources, and it can be anchored in a theory of learning that takes cognisance of the networked, and continuous, nature of learning [11]. This pedagogy can focus on a learning community where, through collective, diverse contributions, connections, and reflection, there is the negotiation of a collective understanding and meaning [11].

With the exploding nature of the access to information, including research articles, it would seem that this model of learning is capable of expressing how postgraduate students gain knowledge about research methodologies. Also, a virtual learning environment should be a tool to help build interconnections between research methodology constructs, allowing the research student an opportunity to make connections between pieces of information and extending these to further maintain and build his/her networked knowledge. Additionally, the Semantic Web and semantic computing tools could conceivably make this networked knowledge machine processable, leading to dynamic knowledge representations and automated reasoning about such representations, with a positive effect on further networking of knowledge and increased learning.

Considered in terms of the eight principles of connectivism [18], learning about research methodologies is centred on the process of connecting research methodology conceptual nodes using appropriate relationships, including the learning that may be found in a Semantic Web environment, and cultivating these connections to ensure continued learning. Not only is the ability to see the connections between the various concepts and relations embedded in research methodologies a core skill, but learning and knowledge in such an environment rely on the variety of views and opinions contained in the domain and the decision-making that is required when choosing which connections to hold on to in terms of current knowledge. Ultimately, the emphasis is on the capacity to not only know more, but to also have access to accurate and up-to-date knowledge.

It does need to acknowledged, though, that, while research methodology courseware can be delivered online at least as successfully as more traditional approaches, with similar student performance [25, 10], there is appreciable variation in experience [26]. Although online participation has been linked to wider opportunities for growth and higher assessment marks, it may not be the preferred approach chosen by some students [25, 26].

3 Research Methodology Semantic Wiki

3.1 Semantic Wikis

A semantic wiki is a merging of the benefits of social software (such as a traditional wiki) with the Semantic Web [27]. It allows for the creation of semantically

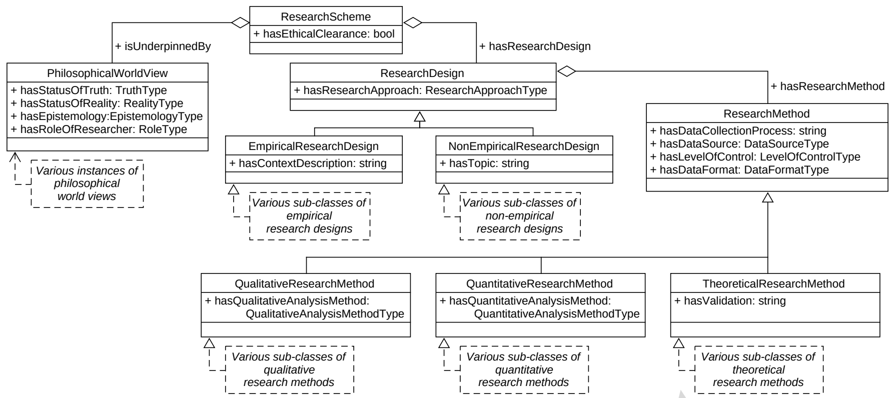

Fig. 1. UML class diagram of the conceptual model.

enriched, formalised domain content that supports collaborative knowledge production and presentation [28]. Web pages are then at least partially machine processable after being tagged with a concept or property name, and queries can also be achieved using SPARQL – the query language of the Semantic Web [29].

A number of semantic wikis were developed after the initial wiki in 2004, with much of the effort happening around 2005 and 2006 [30]. Semantic MediaWiki (SMW), the wiki used for the research methodology wiki, is an open-source extension of MediaWiki [28], which is the engine used to create the well-known Wikipedia, and is considered the most popular semantic wiki engine [28].

3.2 Semantic Wiki Development

Developing the semantic wiki required an ontology of the domain, which, in turn, required a conceptual model. An ontology engineering process was followed to develop such a conceptual model of research methodology structure, followed by an ontology built in Protégé, which was then implemented in SMW.

Briefly, a research scheme is a container for the components that make up a research methodology (Fig. 1). It is made up of a philosophical world view that underpins the research, a research design that provides the structure of the research, and research methods that are used in a research design to gather data. The wiki can be accessed at http://eagle.unisa.ac.za/mediawiki/index.php/Semantic_Web_and_Research_Methodology.

3.3 Semantic Wiki Overview

The main landing page describes the overall structure of a research methodology as well as indicating how the wiki could be used. Other pages describe how to explore the semantics of the wiki, make comparisons between this research

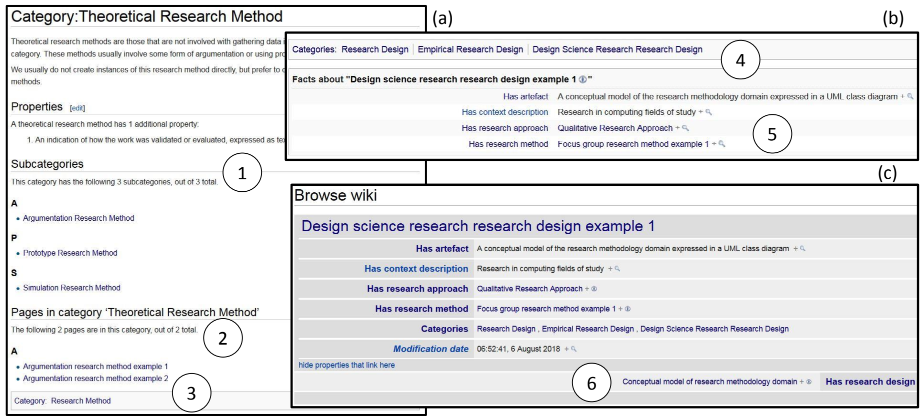

Fig. 2. (a) An example of an SMW *Category* page. (b) An example of an SMW fact box. (c) The SMW Browse wiki view.

methodology structure and others that have been proposed, and indicate how to edit existing pages, add citations, and create new content. A graph view provides functionality to explore research schemes graphically and a link to a special page that allows users to explore any of the categories in the wiki. A breadcrumbs feature was added to provide links to the last five pages visited. The text on each page would be the main content of the wiki, with an associated Discussion page allowing the content, and the justifications for or against it, to be separated. This supports collaborative work, as it enables users to present the main ideas concisely, while, at the same time, using an accompanying page to discuss and argue about the rationale for the content.

Categories and Properties Most pages belong to some ontological entity, having different namespaces to differentiate between, and classify, the entity types [28]. The main and data type classes are represented as *Category* pages, where data type classes are used for entity attributes. All properties (both object properties that point to other entities/objects and data properties that implement entity attributes) are represented as *Property* pages, where the target is the value of property [28]. Thus:

- the *ResearchDesign* class is realised as the *Category:Research Design* page;
- the *ResearchApproachType* attribute of a *ResearchDesign* is realised as a *Category:Research Approach* page;
- the *hasResearchMethod* object property of a *ResearchDesign* is realised as a *Property:Has research method* page; and
- the *hasResearchApproach* data property is realised as a *Property:Has research approach* page.

Category and *Property* pages were populated with basic data describing the entity/property, ensuring that users use them consistently [28]. Even though a

Property: is represented by a page, it is used to create typed linking from one page to another page or data value.

Each individual (or instance) in the ontology is also implemented as a separate, normal page. Thus, the *Pragmatism* individual of a *Category:Philosophical World View* has a page of its own and would contain all the attributes of a *Category:Philosophical World View* as well as a description of the world view. Where the individual is of a class that is lower in the class hierarchy, such as an instance of a case study, it would contain all the attributes of the superclasses, that is, of *Category:Research Design*, *Category:Empirical Research Design*, and *Category:Case Study Research Design*, as well as some extra detail pertaining to that particular case study individual.

Annotations and Browsing the Wiki Annotations are used to make semantic statements about entities in SMW. Even though individuals, categories, and properties are realised as separate pages, the annotations refer to the concept discussed on the page rather than the actual web page itself [31]. These annotations are added to the wikitext using a simplified markup format [28], making page semantics machine readable. For example, adding an annotation on a normal article page declares that page to be an instance of the specific concept. These annotations are used for the instances (or article pages) of specific research schemes, philosophical world views, research designs, research methods, and data types used as entity attributes. When such an annotation is added to a *Category* page, it declares it to be a sub-class of the given category; these annotations were used to set up the inheritance hierarchy for research designs and research methods.

The result of such annotation is that when a *Category* page is displayed (Fig. 2(a)), the subcategories of that page (point 1), the article pages of that category type (point 2), and the page category type (point 3) are displayed dynamically. A further advantage of such semantic annotation is that it allows intelligent browsing of the wiki [28]. Semantic information is dynamically displayed at the bottom of each ordinary article page (Fig. 2(b)): a Categories box indicates what kind of page this is, where the whole category-subcategory hierarchy is shown (point 4); and a fact box displays all the annotations on the page in a linked format, allowing a user to click on a property link (on the left) to visit that property's page (and see other individuals where this property is used) or to click on the property's value (on the right) if the value is represented by another article page (point 5).

A user can also access an inverse link search by clicking on the eye symbol to the right of the page name in the fact box. This takes the user to the *Browse wiki* page view (Fig. 2(c)), which shows the links that point to the current page (point 6). It is, thus, possible to follow this link back to the specific page that points to the current page or to click on the property link that was used to link the two pages. This *Browse wiki* page can be accessed from any link on any page.

Queries SMW has an easy-to-use, inline query engine that allows a query to be included on a page, which then provides updated, dynamic results when the page is accessed. For example, the query (`#ask:[[Has case study design:: SUBJECTPAGENAME]]`) can be used to display all pages that have the property *Has case study design* that point to the current page.

Wiki Individuals To test the functionality of the wiki and to provide content, research articles were read, manually extracting the research methodology structure used, and added as instances or individuals of *Category:Research Scheme*s. The provision of attribute data is not required to allow for cases where reported research might not have mentioned the attributes that have been included in the conceptual model on which the wiki was structured.

3.4 Student Evaluation

Ethical clearance was obtained for a web-based questionnaire to evaluate the utility of the semantic wiki. A link to the wiki was sent to all 316 students registered for an honours research report module, and they were later sent a link to the questionnaire. This was a non-probabilistic, self-selected survey, and the results may not be representative of the entire research student population. Fifty-nine responses were received, representing a 19% response rate.

Demographic and Background Information The respondents were mainly males in their 30s (40%), followed by females in their 30s (26%). Of these, 98% considered their Internet expertise level as good or expert, with 95% using online communication regularly. In total, 96% indicated a strong enjoyment of online tools, although only 53% used social networks often; 86% had used a wiki 10 or more times; and 78% had never contributed to one.

Using the Wiki Table 1 presents a view of student responses to the wiki; percentages may not add up to 100% due to some non-responses. Students found the wiki easy to navigate and indicated that it provided valuable information and helped them understand research methodology structure. However, 81% of the students did not contribute to the wiki, mostly indicating that they did not have enough knowledge (38%), did not think it was necessary (23%), or had no time (21%). Of those who did contribute, 23% were very confident of their contributions, and 62% were sure about them; 67% found it easy to contribute, while 25% noted that it became easier as they progressed. Overall, 43% enjoyed using the wiki, 72% found it useful, and 50% indicated that it made them think and that they would use it again. Only 36% would recommend it.

Themes Seven themes were identified in the textual responses given by participants. Many found it *useful*: it is the "most comprehensive, easy to understand, structure I've ever seen regard[ing] the topic". However, some felt that *more was required*: it is "not enough" to ensure effective learning; "question and answer" functionality should be included. Students also wanted more of an *overview*: a

Table 1. Student responses to the semantic wiki.

	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
Was easy to navigate	45%	45%	3%	0%	0%
Could understand research methodology structure	26%	59%	9%	2%	0%
Provided valuable information	41%	55%	3%	0%	0%

"high level road-map" and "putting the steps one by one so that it will be easy to follow", as well as more *resources*: links to "research methodology articles" and "referencing software". It seems that the instances of research schemes were either not found or too few, as is evident in the call for more *examples*: "an example of each methodology" is an additional feature required. Finally, there may be *lack of confidence* on the part of students to add content, as they are "not sure whether their contributions are correct".

4 Discussion

Some students clearly found value in the semantic wiki, and connectivism can be employed as a theoretical framework from which to explore the source of this value of an applied semantic approach to teaching and learning the structure of research methodologies. It has previously been noted that semantic web technologies and ontologies, which can be used to set up the formal specifications of concepts and relationships, are able to operationalise the principles of connectivism [15]. While it has been noted that Wikipedia can be seen as an instance of connectivist knowledge [13], the extent to which the research methodology semantic wiki can be understood to be a valid approach to presenting domain knowledge will be discussed here. It is noteworthy that connectivism has been used before as an argument to support the ongoing learning that occurs in a knowledge-based engineering environment [24].

4.1 Nodal Structure

The conceptual model of the research methodology structure used in the wiki has a definite hierarchical structure with typed links between the four main entities: (i) the research scheme as a container for (ii) a philosophical world view and (iii) research design, where a research design contains (iv) research methods. Included in this structure are links to object attributes for the types of designs and methods. This structure fits well with the connectivist concept of knowledge as structured [20]. Furthermore, it supports the idea that knowledge of research methodologies can be conceptualised as a network that is not just a flat, linear set of entities [21], but that the links/connections between the entities carry semantics and meaning. The semantic wiki provides the connections between concepts, providing a pattern to be discovered.

This structure can also be interpreted as nodes (see Fig. 3; text in italics will refer to the specific detail in this figure). The whole site may be seen as a node to which a knowledge network can link as a place to find information about the structure of a research methodology. One level of granularity down, a whole research scheme may be seen as a node; these nodes can be taken as instances of research reports that have been published in journals and conference proceedings and are, in a sense, self-contained. The research scheme concept grows by connecting to other concepts [20] – concepts such as ethical clearance, philosophical world views, and research designs. A research scheme can also be interpreted as a pattern – a set of connections tied together as one whole [20], with meaning about the roles of the included parts encapsulated in this pattern.

Continuing into the structure, it is then possible to zoom into one of the research scheme nodes to find the sub-nodes contained within it and to explore how these are structured: it contains a link to a world view (*Pragmatism*), some indication of an ethical clearance, and a link to a research design (*Design science research*). Zoom into the design node to find an approach type (*Hybrid approach*) and other nodes specific to the type of design being used (*Context*, *Artefacts*), as well as a link to a research method (*Focus group*). Zoom into that node to find nodes that give detail about the specific method that was used (*Low level of control*, *Five participants*, *Thematic analysis*, *Face-to-face*). Additionally, following a link from one of the properties (such as the hybrid approach in the design science research node) will take the student to other types of approaches that could have been used.

Any technology-enhanced environment, such as a semantic wiki, that is to support a connectivist approach to learning needs to structure/organise knowledge and handle the connections, so that information is discoverable [15]. A semantic wiki is also able to handle the dynamic nature of growing knowledge through the queries that can be placed on pages. Thus, as new instances (with their associated links) are added to the structure, these will show up automatically on the appropriate pages. This, again, emphasises a connectivist model of knowledge, its changing nature, and the importance of knowing where to find the most current information.

It has, furthermore, been argued that nodes have autonomy, with the result that concepts can accept or reject connections to other nodes, largely as a result of the connections that are currently linked to concepts, leading to differences of opinion and reasoning [20]. So, although the structure (nodes and links) is provided by the semantic wiki, the content of a node, and strength and status of a link (active or inactive), in the mind of the explorer of the wiki are not always the same between individuals, and so there will be different ideas about the value of the wiki. Thus, some supervisors, and students, may find the structure useful, and others not.

4.2 Learning

Semantic wikis can be seen to facilitate learning when viewed from a connectivist model of learning. When presented in a semantic wiki, a research student

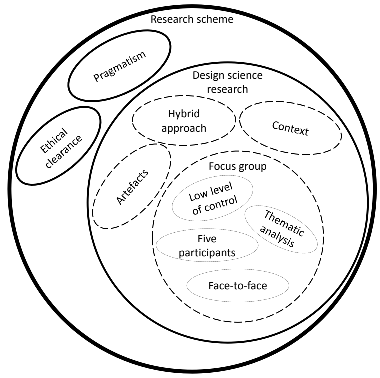

Fig. 3. Zooming into a research scheme node.

is able to follow typed links, promoting a connectivist approach to learning [15], as the student explores the networked knowledge about research methodologies present in the semantic wiki. A student is able to see the interconnectedness of the concepts by following the links to more information and can so build paths of knowledge through the chaotic maze of terminology that characterises the domain. Furthermore, the connectivist view of learning as pattern recognition applies here: students see, and can acquire, the pattern of linkages and relationships that makes up research methodology concepts, getting the meaning represented by the pattern to be accepted by the current concepts that are held.

Also, when two concepts are connected, it allows knowledge of the one to be transferred to the other [20]. In the semantic wiki, since one research design can be replaced by another (as they are seen to be connected by the inheritance relationship), it allows the knowledge that the student has about one research design, what it is made up of and how it relates to other parts of a research methodology, to be transferred to the new design, although some specifics will need to be reorganised.

Connectivist learning has been characterised by four activities – aggregate, relate, create, share [24, 32], also called aggregate, remix, repurpose, feed forward [23] – and four levels of interaction – operation, wayfinding, sensemaking, innovation [33, 19]. These may be reinterpreted for explaining learning in this research methodology semantic wiki, as well as considering the critical skills needed.

1. Operation: initially, students need to master the technical human-wiki interface necessary to participate in the learning available in the wiki. This basic interaction points to a critical literacy required to be an effective connectivist learner using this wiki.
2. Aggregation and wayfinding: students access the resource, learn to navigate it, and build connections between nodes that they find reliable within it. In aggregating concepts around a research scheme, for example, students learn what it consists of and how the parts relate to one another. Students also

need to judge the content and connections to determine what is important and valuable – another critical literacy required. Students orientate themselves in the spacial structure presented by the wiki and develop a loose network.

3. Relate, remix, and sensemaking: students reflect on what they have found and use research scheme instances to relate to their own experience and how past research has been conceptualised and patterned. In sensemaking interactions, they construct patterns of meaning and understanding (leading to a consistent comprehension) and remix concepts from different domains (rearranging parts to meet their needs by changing some connections to link to more appropriate nodes/concepts for their particular research). The result is a tighter network. Here, critical analysis skills are needed.
4. Create, repurpose, and innovation: students now create something of their own; they build their own research schemes from the knowledge that they have gathered and reworked within the network and so build up their own patterns. Thus, a certain level of ability to create and innovate is another connectivist critical literacy, and innovation interaction is the deepest, most challenging, and applied level to reach.
5. Share and feed forward: students then share what was created with others, and the discussion pages in the wiki further allow students to share their ideas about why choices were made and to discuss these with other people.

By actively using the wiki in getting students to comment on the discussion pages about a research scheme or its component parts, supervisors will be supporting students to aggregate. Furthermore, students could use the wiki to construct their own research methodology pathways in the wiki and justify their choices, which would take students through the other three phases of learning via a semantic wiki. Thus, in a sense, students become content generators, as they restructure the information contained in the patterns they have seen in the semantic wiki to form new patterns that they can use in their own research methodology [20]. The semantic wiki is then able to act as the place of interaction between supervisors and students, which leads to knowledge [13], and further cements the link between the wiki and the connectivist learning model. In this study, the extent to which students created research schemes for their research reports is not known. However, there was no sharing of ideas evident in the wiki, as it appears that there is little confidence among the students to engage. This result has been reported before, where only a minority of students created an artefact [32].

It is worth remembering that the new aggregation or organisation of existing knowledge is new knowledge, as such compounded nodes are greater than the sum of the parts/nodes [20]. So students, in gathering together parts of a research scheme to make up a research methodology structure for use in their specific research projects with specific questions, are learning and generating new knowledge.

In some senses, then, the work of the supervisor is to find the best way to make use of such networked knowledge to enhance student learning [23]. It is necessary, though, to appreciate the level of autonomous, self-directed learning that is called for in connectivist learning when students have to find resources, make connections, and independently take responsibility for their learning [32]. Furthermore, it is not the mode of delivery that is of importance, but the representation of the content [10], and a semantic wiki may well be an efficient strategy for using connectivist ideas to support student learning.

5 Conclusion

Although “learning research methodology is a multifaceted and intellectually challenging endeavour” [5, p. 230], it is a task that students undertaking research have to master to some extent if they are to produce acceptable research outputs. The move to use technological tools in higher education, including the Web with its access and collaborative affordances, has included alternative approaches to the research education that accompanies the learning of research methodology. In this work, we report on one such attempt that uses the Semantic Web, in the form of a semantic wiki, to support the learning and teaching of the structure of a research methodology. Results pointed to it being well received by students.

However, it is worth remembering that the use of advanced, or online, technology is not necessarily going to lead to better-quality learning or success [34]. Teaching and learning should not be turning to the unquestioned use of technological advances, but rather to a thoughtful practice of pedagogical principles [10]. Connectivism can provide these pedagogical principles in the case of the semantic wiki explored here and lays a good foundation for understanding how semantic technologies may be of value. Furthermore, semantic wikis equip a course designer with tools that can be used for developing, supporting, and maintaining network formation, which would support connectivist learning [33].

The connectivist approach to learning places a focus on a networked view of knowledge and its acquisition, which is strongly supported by the semantics available in a semantic wiki. Also, it encourages the gathering and reviewing of a wide variety of resources, points of view, and judgements of what is of value, before reaching decisions about the creation of a student’s own opinions and new knowledge. In a sense, connectivism allows one to think in new ways about objects of learning and how they can be presented to students [33].

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