

When scholars use Knowledge-Step Forums to create Web-Compended Guides to the literature of their fields, paradigm-shifts will occur in the processes of knowledge creation and in graduate education.

"Publication forms the core structure supporting the development and transmission of scientific knowledge" (Galbraith2015). Yet, with the WorldWideWeb a dominant part of current scientific publication and information-dissemination, internet "publication" is still ***paper-based*** in its style and methods. ***As will become painfully obvious, such a paper-based "publishing model" is NOT adequate for a Web-based world.***

Consider that in 2011, an estimated 5,000 peer-reviewed scientific articles were published ***per day*** (Outsell2013), and that in 2014 just the English-language scholarly publications on the Web were about 4,900 ***per day***.

In 1980, the distinguished scientist Garrett Hardin wrote [Hardin1980]:"Who can keep up with such a torrent? When I was young and foolish I vowed that I would read all the articles in my small field of science. Discovering that this was impossible, I tried to read all the abstracts. That, too, proved too much. Now I know that I cannot even read all the titles."

To help reduce scholarly information-overload, this article proposes using Knowledge-Step Forums for the purpose of creating ***a new type scholarly publication, Web-based Compendia***. *Each Compendium is about a very narrow topic and is presented in a MultiLevel Format. When all these features are combined, the scholarly article is called a Knowledge-Step Compendium, and it is posted on the Web by the scholar, either on an institutional server, or on one of many web-hosting servers. Web-search engines will be automatically notified about the new posting (and later changes, too).*

Forum-Compensors need not be a senior faculty member (as is the case in traditional literature-reviews), but can be pre-docs, post-docs, and senior medical/surgical residents. These graduate-students will be aided by their mentors and online experts to create these Knowledge-Step Compendia. *All participants (students and faculty) will be motivated by their own self-interest and everyone gains from the activity, which self-organizes groups of like-minded scholars. Such groups can be the basis for early reviews of new data, for discovering new ideas, and **for finding jobs.***

Knowledge-Step Forums will speed publication on the Web because it will easily support Publication of Preprints using the software's automatic collection of online "peer-review" comments.

In order for the Internet to be an efficient searchable repository of current and developing knowledge, one additional feature will be needed: ForwardLinks must be available in any given publication to those articles that, in the *future*, cite the given publication, as fully described in a Supplement to this article. Open-source software for this functionality should be on all Web-servers that contain scholarly articles, so as to make the WWW a distributed web full of linkages, of both ForwardLinks and RetroLinks.

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by

Don L. Jewett

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Research Director;
Abratech Corporation;
Mill Valley, CA, USA

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Professor Emeritus;
University of California, San Francisco;
San Francisco, CA, USA

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Corresponding Author:
Don L. Jewett, M.D., D.Phil. (Oxon)
69 Ridge Ave., Mill Valley, CA, 94941, USA
dlj@abratech.com ; don.jewett@ucsf.edu

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INTRODUCTION:

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Intro.1 Where We Are

Quoting from the first paragraph of the Abstract: ***As will become very obvious, a paper-based "publishing model" is NOT adequate for a Web-based world!***

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Question: Will further adaptations and adjustments to the paper-based publishing-model be sufficient for present and future needs?

The Author's Answer: "Not at all"; the Knowledge-Tool described in this article is ***needed now***, and will be ***absolutely necessary in the future***, when even more articles are published.

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To make this clear, one must *distinguish between* **Information** and **Knowledge**.

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Intro.2 A Maxim

The Author has composed a maxim for Science and Medicine:

Numbers *alone* are ***not*** Data;

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Data *alone* are ***not*** Results;

Results *alone* are ***not*** Information;

Information *alone* is ***not*** Knowledge;

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Knowledge *alone* is ***not*** Wisdom.

The phrase "Information is not Knowledge" is from a song by Frank Zappa. (The authorship has been erroneously ascribed to Einstein.) Discovering the phrase stimulated the Author to both write the maxim, and to puzzle about the processes by which Knowledge was actually created. The Author, despite decades dedicated to both Research and Teaching had never considered *in any detail* whether there were systematic means by which Research Information was turned into Medical or Scientific Knowledge. Information and Knowledge, in the author's previous thoughts, were jumbled together; research articles, textbooks, reviews were all equally "publications".

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This article has un-jumbled them for the author, and may do the same for others. But, if Zappa's phrase is correct, then **by what means does Scientific Information become Scientific Knowledge?** For the Author's answer, see Fig. 1, below.

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Intro.3 Knowledge Paths

Fig. 1 (Title): Two different Knowledge Paths to the creation of under-graduate textbooks.

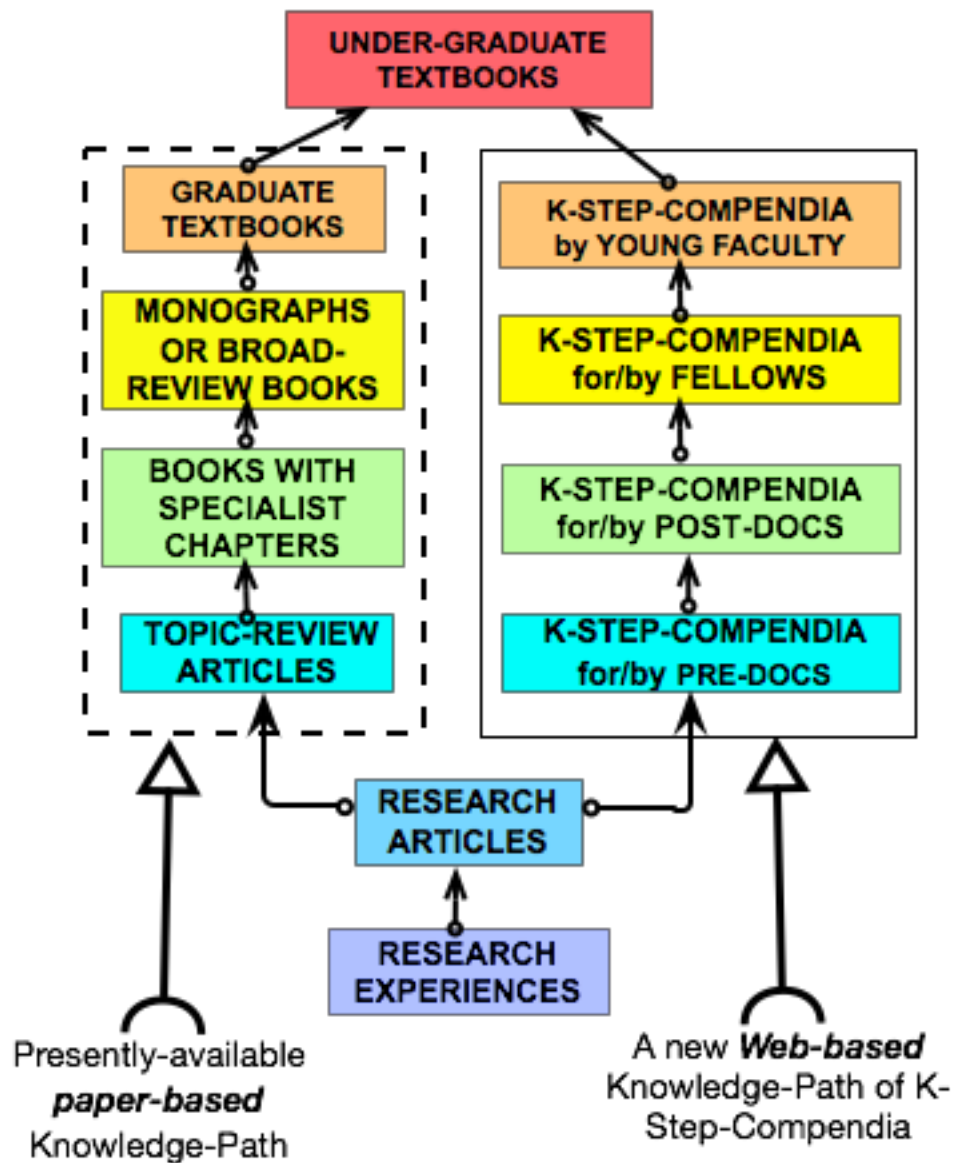


Fig. 1 (Legend): As Knowledge is created from Experience, Information, and prior Knowledge, multiple steps are needed to make the Knowledge useful. Two Knowledge-Paths are shown (in two columns): 1) the presently-available paper-based system (*left* column), and 2) the Web-Based K-Step Compedia method proposed here (*right* column). "K-Step" is short for "Knowledge-Step." The differences between the two Paths are the main subject of this article.

Fig. 1 illustrates a number of important points:

1. Moving **upward** in the Figure, from one publication-type to the next, Information **decreases** (there is less particularity), while Knowledge **increases** (there is more generality).
2. As Knowledge increases by Knowledge-Creation, the decreased particularity and increased generality make it easier to **learn a given Knowledge level**. As a result students can master the material more rapidly than the creators of the Knowledge-Path were able to do.
3. It is notable that, in these paths, written material is different for different readers. These "levels" are the same in both Paths, as indicated by the **matching fill-in colors** in **both** the **paper-based** and the **Web-based Knowledge-Paths**.
4. When the steps on the Knowledge-Path have been delineated (by repeated compendizing), one can see that the **same steps form an "Education-Pathway"** when traversed in the **direction opposite to that of the Knowledge-Path (i.e., downward)**. At the top of the Figure, Under-Graduate Textbooks form the start of the Education-Pathway by which the next generation of scholars learns a given field. **Moving downwards on the Education-Pathway, one moves towards higher academic degrees (more particularity)**.

To reiterate: the Education-Pathways are the same as the Knowledge-Paths, except that the Education-Pathways are traversed **downwards in the Figure**, whereas the Paths of Knowledge-Creation are followed **upwards in the Figure**.

A full "cycle" can be described thusly:

Knowledge is successively created by moving from particularity to generality. This effort requires the work of many scholars, over time. When the Knowledge-Path is sufficiently consolidated, materials for an Education-Pathway can be created. Neophytes start the Education-Pathway at generalities, and then move to those particularities that are important at a given level in a given field. Scholars with advanced degrees learn to create more Knowledge (see Compendors.1, below), possibly in new or expanding fields, and the cycle can repeat with new or enhanced content.

5. Whereas the paper-based Path (left side, Fig. 1) is presently well-known, with established (yet inefficient) methods, the K-Step-Compendium Path (right side, Fig. 1) involves **new Knowledge-Tools in addition to presently-available Tools**.
6. Figure 1 is intended to diagram the **paths as Knowledge is created**. It does **not** show what must be combined to create a given "level". To indicate that each level is built upon a level that is larger, there is Fig. 2.

Fig. 2 (Title): Imaginary comparison of number of publications from lower levels, in different given levels of a Knowledge-development sequence.

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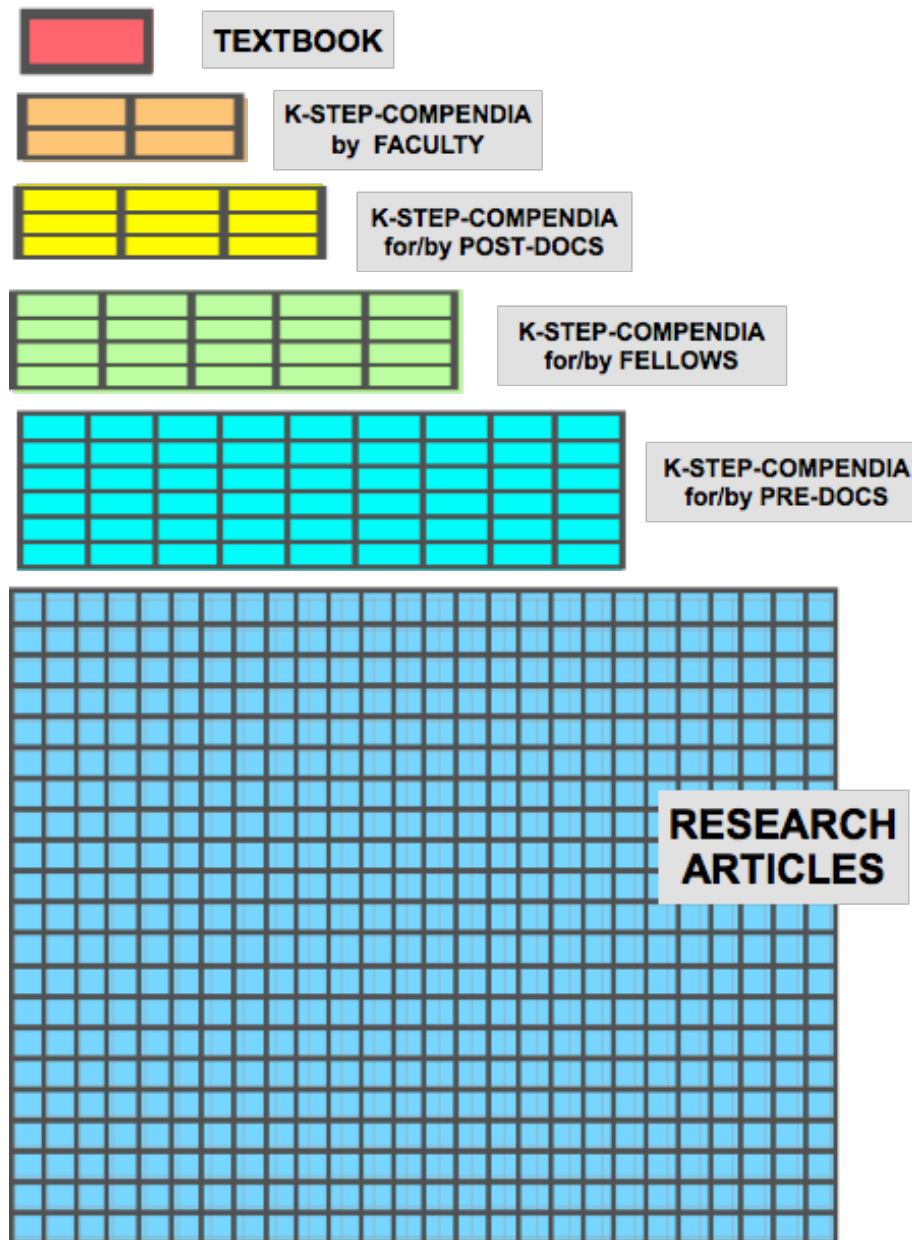


Fig. 2 (Legend): The different sizes are not to any scale, and are intended only to indicate that any given Knowledge-Step is based on a large amount of material from one or more steps below. "K-Step is short for "Knowledge-Step".

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With the understanding that Fig. 1 only shows *pathways*, we can return to the issues that arise when creating knowledge.

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Intro.4 Definitions: re "Knowledge"

- Compendium** = a scholarly publication that is *a concise, yet comprehensive, guide to earlier literature*. (plural = Compendia) 150
- The activities needed to create a Compendium are referred to as "Triple-C", where the mnemonic stands for: **C**ompiled, **C**ompared, and **C**ompacted.
- It is possible for a written presentation to be both concise and comprehensive, by use of a MultiLevel-Format (see Tools.4). 153
- Compend** = (neologism) a verb derived from the noun "compendium", to indicate the "Triple-C activities" essential to creation of a compendium. 156
- Web-Compended Guide** = a scholarly guide to available literature, created by compending on the Web.
- Compendor** = (neologism) a noun derived from "to compend" to indicate someone who is active in creating a compendium. 159
- Knowledge-Step Forum** = an online WebSite where a Compendor, together with other like-minded scholars, creates a new Knowledge-Step Compendium. A Knowledge-Step Forum utilizes some of the features of present online forums and blogs, but has additional necessary features. 162
- Knowledge-Tool** = a mechanism, method, or behaviors that aid scholars during creation of knowledge. 165
- Knowledge-Step** = one part of a Knowledge-Path, having an amount of Knowledge roughly estimated as that which can be understood by a single knowledgeable Compendor or a small group of compendors. A Knowledge-Step covers less material than a usual Ph.D. thesis, being limited by a narrow-topic. (**K-Step** = Short form of "Knowledge-Step".) 168
- Knowledge-Path** = a sequence of Knowledge-Steps, wherein, moving along the sequence, the Knowledge-generality *increases* while the Information-particularity *decreases* (see Fig. 1). Moving in the *opposite direction* in the Knowledge-Path sequence is named an Education-Pathway (*q.v.* below; see Fig. 1). (**K-Path** = short form of "Knowledge-Path".) 171
- Education-Pathway** = the sequence of Steps of a Knowledge-Path, sufficiently-developed for educational purposes, wherein moving along the Pathway sequence is in the *opposite direction* from that of the Knowledge-Path (*q.v.* above; see Fig. 1). 174
- K-Step-Compendium** = a narrow-focus Compendium that integrates with other Steps (see Tools.4). "**K-Step**" is the short form of "Knowledge-Step". 180

K-Step-WebSite = a WebSite that provides online K-Step "Tools", e.g., *K-Step Compendia, K-Step PrePrint Critiques, K-Step Archives, K-Step Forums.*

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Forum-Compensor = the organizer/moderator of a Knowledge-Step Forum.

Intro.5 Overall Design of Knowledge-Step Compendia and Forums

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Knowledge-Step Compendia are specifically designed so that individual K-Steps can be organized into a K-Path. This is accomplished in several ways:

1. the topics are *narrow* so as to reduce the number of K-Paths a given K-Step will correlate with;
2. the MultiLevel-Format (described later) puts the most important issues related to a K-Path *first and foremost*;
3. a regularized presentation makes it easier for Readers, including the next-level Compender, to read and understand the conclusion reached, and the experimental support used.

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The Knowledge-Step Forum can become a *very powerful tool for organizing knowledge* when used to create K-Step Compendia. Several features contribute to its strength:

1. experts from around the world can be involved in the wording of Assertions that are made about a given topic;
2. the MultiLevel-Format keeps the topics focussed on the issues important in placing the topic within the relevant K-Path(s), especially the experimental evidence;
3. all participants have motivation to create a high quality Compendium based strongly on *self-interest related to their careers and reputations*;
4. all submissions to the Forum have protection against plagiarism, by a Chained Hash Algorithm (described later).

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Intro.6 Costs

The creation of valid, useful Scientific-Knowledge from Research-Experience (Information) can involve many steps. The number of steps necessary to reach a given level depends on the starting level, and on who is to receive and utilize the Knowledge.

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However: every step requires *human effort, human ingenuity, and, **most critically,** human time.* The extra time needed to make a complicated issue concise and clear

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has been known for centuries. In 1657, Blaise Pascal wrote "I have made this [letter] longer than usual, only because I have not had the time to make it shorter." [Knowles1997]. 213

The "Standard Path" (based on the presently-dominant Paper-Publishing Model) has notable *financial barriers at all steps*: Will an Article or Topic-Review keep present reader subscriptions at a profit level? Will a Monograph or Book sell enough copies to cover the "costs" (of the Publisher's other books that are losing money)? Will a Textbook sell to more than the Author's own students? 216 219

In marked contrast, the proposed Web-Based Knowledge-Step Compendia Paths have no out-of-pocket financial-limitations, because:

1. All posting is Open-Access (no subscription-limitation on readership); 222
2. There are no "authorship" charges; and
3. The only (small) funds required by an Author are for WebHosting (if at all).

Intro.7 Increasing numbers of specialities 225

Addressing now the larger picture: When increasing numbers of scholars, specialists, fellows, and faculty are involved in scientific and medical research, it is not particularly surprising that there is an increase in the *number* of publications. What is less clear is the additional increase in the *number* of **specialist-fields**. 228

Recognize that each specialist (being human) has limitations in learning speed and capacity. Also, each specialist has limited time available to reach a given vocational level. It follows, from these limitations, that an increased number of specialist-fields is an indication that the *amount and rate* of Knowledge-Compending with presently-available Knowledge-Tools is **failing to keep up** with the Information-Expansion due to expanded scientific and academic activity. 231 234

This *failure can be mitigated* by what we herein propose:

1. *More efficient Knowledge-Tools*, and 237
2. *Larger numbers of human Knowledge-Compendors*.

Intro.8 Summary of this Introduction

- Returning to the Question at the bottom of p.6: "By what means does Scientific Information become Scientific Knowledge?", the summary of the Author's Answer is this: 240
1. Knowledge is created by Scholars into Knowledge-Steps, using the Knowledge-Tools that are available to them at the time. In general, each Compending creates only one "step" in the Knowledge-Path. 243
 2. A notable problem with the "Paper-based" publishing model, is that each step has *financial constraints* and this leads to **Closed-Access Archives**, including those of "Review Articles". In contrast, the use of Knowledge-Step Forums to generate Knowledge-Steps consisting of K-Step Compendia in a MultiLevel-Format can be "Published" by individual Compendors, **by posted on the Web with Open-Access**. 246
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 3. Can the rate of *Knowledge-Creation* be increased? **Yes**. But increasing the rate of Knowledge-Creation *will involve at least the following changes*: 252
 - 1) *accepting Knowledge-Step Compendia with a MultiLevel-Format as a new, additional alternative for "online publication" of narrow-topic Reviews; and*
 - 2) *recruiting new Knowledge-Compendors*. 255
 4. These changes *need not be imposed upon any participant* because *participation* will be motivated by the *self-interest of each individual that is participating* (see Tools.8 and Tools.10). 258

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TOOLS:

Tools.1 Knowledge-Tools: past, present, and future

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In the past, the primary Knowledge-Tools consisted of *paper-based Libraries* equipped with:

1. Books; 264
2. Journals with Articles;
3. Catalogs & Indexes.

Presently, Knowledge-Tools consist of Libraries with mixed media:

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1. Books, some paper-based, some on WebSites;
2. Journals with Articles, some paper-based, some on WebSites;
3. Indexing-WebSites. 270

In the future, Knowledge-Tools *on the Web* should consist of the following:

1. Books on WebSites;
2. Journal-WebSites with Articles (*unchanged* from the present); 273
3. Indexing-WebSites (*unchanged* from the present);
4. **New K-Step Compendia** providing specialized (MultiLevel) Compended-Guides to the literature of a narrow topic. The Compendia will be most easily created in Knowledge-Step Forums. This requires new Software. A subset of the Forum-Software can also be used to post Compendia and receive new comments and citations after posting (an Active Archive). 276
5. **New K-Step Forum WebSites** that facilitate Compending of Knowledge by providing the basic tools, and perhaps some luxuries, too. 279
6. **New Preprint-Critique WebSites**, also using K-Step Forum Software, which will provide an easy method for Authors to obtain and use critiques of their work, at different stages. The K-Step Forum Software also provides protection against plagiarism (see Tools.12). 282

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Tools.2 The Rules and Features of Knowledge-Step Forums

A Knowledge-Step Forum operates under the follow <i>Rules</i> (unless modified at setup by the Forum-Compendor):	288
1. The <i>entire WebSite</i> can be read by anyone, without restriction (full Open-Access).	
2. The SiteAdmin can be contacted by any User, without any registration required (in case an unregistered Reader wants to report a problem without spending the time and effort to register).	291
3. Submissions (contributions) are accepted only from Registered Users (email verification required) who use their own names. In rare instances, an exception to this rule can be made by the Forum-Compendor, with appropriate justification; the communications regarding these exceptions are not saved by the system, but are listed by date in the History, as "User Exceptions, Reviewed and Accepted".	294 297
4. All submissions are posted under a Creative Commons License that is specified on the WebSite and specifically agreed to, by each Contributor, during Registration.	300
5. The Forum-Compendor is solely responsible for placement in the Knowledge-Step Forum of every submission received (see rule #6). This activity can be assigned to an Editor by the Compendor.	303
6. Each submission <i>must be placed</i> by the Compendor/Editor <i>into one of the six main Sections</i> within the Knowledge-Step Forum:	306
1) Assertions	
2) Conjectures	
3) Observations for Stronger Inference	309
4) Public Comments	
5) Scientific Comments (general)	
6) Rejected Submissions	312
This list may be changed at the discretion of the Compendor, as needed to best fit the needs of the Forum's <i>Narrow-Topic</i> .	
7. Specific Comments about a Submission, from the Forum-Compendor and/or other Readers, are placed in an Extension of that Submission's primary location.	315
8. All submissions to the Knowledge-Step Forum WebSite are saved, unchanged , in the History of the WebSite (automatically by modified Version Control Software). This protects the Forum-Compendor from accusations that bias has affected either the editing or the placement of the submission within the WebSite. Inappropriate language can be redacted before placement. Communications	318 321

- related to the submission-process are available by links from the submission to the stored material. Material that was initially placed in the Compendium, *but later rejected, will still exist in the WebSite History*, and, in this way, any Links to or from such material (see MetaLinks in Supplemental material) will still be valid and functional if they are based upon textual material that can be searched-for!
9. All submissions (accepted or rejected) are processed by a CHA (Chained Hash Algorithm) and the appropriate content and hashes are stored with the MetaData associated with the submission.
 10. Readers will be able to find new content in the Knowledge-Step Forum by word and phrase searches in web-search-engines because such engines, as specified by the Forum-Compendor, will be automatically notified whenever new submissions (larger than a specified size) are placed within a Section.
- The following are some *additional features* of the Knowledge-Step Forum Software:
1. The Software automatically handles routine communications, using the email addresses provided by the Compendor.
 2. The Software acquires and makes available to the Forum-Compendor, Editor, and SiteAdmin statistics on usage, origin of non-registered Readers, etc.
 3. Changes to the code of the Open-Source Content Management System can only be made after the SiteAdmin has signed off having read warnings concerning the possible adverse effects of changes on Site performance or behavior.
 4. Presentation of content is uniform across K-Step Compendia unless the Forum-Compendor finds a need for additional features. The options available to the Reader, and how to control the options, are also uniform across K-Step Compendia. This uniformity makes it easier for the Reader, once accustomed to the format, to access different paths within Forum Software.
 5. Despite the described uniformity, many parts of Knowledge-Step Forums and MetaLinks are highly adaptable to the needs of the Compendia Scholars and Readers. The adaptability includes different needs for different fields, and the changing needs of changing fields.
 6. The Software is compatible with existing Browsers and Word Processors.
 7. Use of the Software is intuitive, and does not require the use of Manuals, or extensive Help-text.

Tools.3 Definitions: *re* "Format"

MultiLevel Format = a format for presentation, which uses typographical conventions (explicitly defined by the Author), to distinguish different "Levels" of content within the writing [Jewett1981]. A MultiLevel Format provides *different readers* access to *different content*, making the writing less linear and more multi-path. It also provides the *same reader* with content at the level needed by *that reader at that time* (which can be different at a different time). 357 360

Stronger Inference = the Author's revision of Platt's "Strong Inference" [Platt1964], such that the process **starts with an *observation*** that cannot be adequately explained by existing knowledge [Jewett2005]. 363

Stronger Inference was included as part of what the Jewett2005 article labels "Strong-Inference PLUS". To avoid possible confusion, understand that there are three components to "Strong-Inference PLUS": 366

1. The **Preliminary Experiments** to obtain initial observations to start the process of #3, below, 369
2. The **Initial Observations** (unexplained by current knowledge), and
3. The **process** of listing and then testing possible explanatory hypotheses, originally called "Strong Inference" by Platt (Platt1964). 372

The "Stronger Inference" used in this article is the combination of Numbers 2 and 3. 375

Tools.4 A MultiLevel Format for K-Step Compendia.

Each Compendium should be devoted to a *Narrow-Topic, presented in a MultiLevel Format*. One possible MultiLevel Format for K-Step Compendia will now be explained. It contains **Three Main Sections, each with multiple Levels**, as shown in Fig. 3, next page. 378

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Fig 3 (Title): Possible Sections and MultiLevel expansions for a Compendium-Format.

Sections ⇓	Level 0 Section Starting Point	Level -1 Section Expansion	Level -2 Further Section Expansion
ASSERTIONS what we -- KNOW --	A List of Assertions	For each Assertion: a list of available Evidence each with a critical Evaluation	For each Evidence: a list of Methods for new Evidence for/ against the Assertion
CONJECTURES what we -- MAY COME to KNOW --	A List of Conjectures	For each Conjecture: a list of Reasons for/against, each with critical a Evaluation	For each Reason: a list of possible Methods for/against the Conjecture
STRONGER INFERENCE what we -- DON'T KNOW --	A List of Observations, each not clearly understood with present knowledge	For each Observation: a list of all alternative, testable Hypotheses	For each testable Hypothesis: a list of Methods for obtaining Evidence for/ against the Hypothesis

Fig. 3 (Legend): On the *vertical dimension* of different Sections, the range of possible Knowledge about the topic is covered by what we: 1) Know, 2) May Come to Know, and 3) Don't Know. Thus, at Level 0 are corresponding lists of 1) Assertions, 2) Conjectures, and 3) Observations (not presently explainable).

On the *horizontal dimension* is the expansion of each Section. In the first expansion (Level -1) the evidence, reasons, or alternative hypotheses are presented and evaluated. Further expansion (Level -2) deals with possible methods by which to improve knowledge of the topic.

Each Section can be easily expanded in the **horizontal** dimension by the Reader to *additional levels*, using cursor clicks or keyboard strokes. The novice Reader, desirous of an "overview," can avoid the technical levels that are of interest to the expert, such

as experimental detail, and debates concerning the adequacy of proffered evidence. A more advanced Reader can expand a section to find material of interest.

This MultiLevel Format is **a powerful tool for *any* Reader**, who can first see an overall structure in the top levels, and then take a path down into the material to a level that is best for *that particular Reader, at that particular time*. 396

The **Assertions-Section** contains a *List* of Assertions, *i.e.*, statements considered to be "generally believed" and/or "well-established". For a *given* Assertion, the Reader can, by an expansion, immediately see the Evidence for (and against) the Assertion, critically evaluated. By another expansion, descriptions of new research methods that may provide new Evidence can be seen. 399 402

NB: The MultiLevel Format **does not exist in present review articles**.

Because the Assertion-Section contains only Assertions and their Evidence, the overall "structure" of the field's accomplishments is made apparent. Assertions need to be evaluated based on the strength of the evidence that supports them. The most important Assertions are based on the best evidence and they provide the strongest "structure". Weak assertions are better placed in the Conjectures Section, so that the weaknesses can be explicitly stated, and a possible route to better evidence can be delineated. 405 408 411

"One size *may not* fit all." In the case of the Assertions-Section, the Compendor may find that a further classification is needed for the material submitted. For example, topics that are in contention could be subdivided into "Conventional Assertions" and "Unconventional Assertions". Such subdivisions may be suggested by Readers or Contributors. The goal of the Compendor should be the best presentation of the given topic, and some experimentation may be necessary to find the best organization. Indeed, different organizations of Knowledge could be the basis of the use of newer Formats in some topic-areas. 414 417

The **Conjectures-Section** contains a *List* of statements (written in the form of Assertions) within the purview of the Narrow-Topic of the Compendium, but having an inadequate experimental basis to be considered an Assertion. By an expansion, the Reader can then see the reasons that support or refute a given Conjecture, while further expansion can reveal possible experimental methods that might prove or refute that Conjecture. 420 423

The Conjectures-Section (which **does not exist in present review articles**) can contain contributions from those scholars who do not have the time and/or resources to pursue an idea, even a good idea. Such scholars include Emeritus Professors, Investigators whose grant applications were not funded (80% of applications!), "post-docs" working outside of their original fields, researchers who have ideas (but for one reason or another, do not have facilities or support to test them), or those who (though having research training) work in institutions or at jobs where research is not possible. The Chained Hash Algorithm (described later) will ensure that anyone submitting a Conjecture that is posted online in a Knowledge-Step Forum **can receive proper credit**, even if the words or ideas are later plagiarized.

Because of this automatic protection, submitting unpublished ideas to a Conjectures Section is *actually desirable from the Contributor's standpoint, in order to establish priority about the idea*. This is similar to the effect of preprint publications today, but without the requirement for data before being able to qualify as a preprint.

The Conjectures Section is important because informed conjectures may provide a basis from which **new advances** can occur, as has occurred repeatedly in the history of science. The Section may also contain hints of the benefits and problems of different experimental paths that may be of use in working on a Conjecture.

It is expected that the *placement* of a given entry in one of the six main sections of a Knowledge-Step Forum (see Tools.2 Rule 6) can be *dynamic*. A given statement may start as a Conjecture and later be moved into the Assertions Section (or *vice versa*), as the evidence builds, over time.

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The **Stronger-Inference Section** will have a *List* of Observations that, by present Knowledge, are not understood. (Again, this **does not exist in present** review articles.)

Note: It is critically important to *not start with a hypothesis*, even though popular descriptions of science state that a hypothesis is the starting point of a scientific study. The reason to *not start with a hypothesis* is described in a wonderfully honest, insightful quote from T.C. Chamberlin, a geologist, who, in **1897**, said:

"The moment one has offered an original explanation for a phenomenon [and the explanation] seems satisfactory, ... [At] that moment affection for [one's] intellectual child springs into existence, ... and as the explanation grows into a definite theory [one's] parental affections cluster about [the] offspring and [the theory] grows more and more [valuable and indispensable]
"There springs up also unwittingly a pressing of the theory to make it fit the facts and a pressing of the facts to make them fit the theory...."

From [Chamberlin1897]; slight editing shown by brackets.

To avoid this **otherwise inescapable trap**, the Author recommends "Stronger Inference" which *starts* with an **observation that has not yet been understood**. (Also see Definitions, above.) This must be followed by enumeration of **all alternative hypotheses** that might account for the observation, based on present knowledge. Then, using experimentation or observations, *hypotheses are rejected or not*. **The skill of the scientist is evident by the number of hypotheses a given experiment can rule-out**. The process continues until a single hypothesis remains that has survived an experimental test by which it could have been rejected. This remaining Hypothesis is the "currently-held view" of the "cause" of the Observation (and so could become an Assertion in a Compendium).

To the laity, this remaining hypothesis is "truth," but the Scientist knows that this currently-held view can change if new Knowledge leads to new Hypotheses. If so, then one must return to Experimentation and rule-out the new Hypotheses.

It is commonly stated that one can "only disprove a hypothesis, never prove one". Whether this is true depends on the *specificity of the hypothesis*. **If the hypothesis is a broad generalization** ("All swans are white"), then it can **only be disproven**. On the other hand, **if the hypothesis is limited** ("Sometimes in this pond, one or more swans

are black"), then **the hypothesis can be proven**. This difference is especially important in Medicine, where the hypothesis is often limited ("This patient has tuberculosis"), and the diagnosis can be proven by a single test (e.g., sputum analysis).

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A Critical Note: In Medicine, a "Differential Diagnosis" has a structure very much like Stronger Inference!

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1. In documenting a patient's medical condition, first, the physician describes a "chief complaint" (an Observation chosen from the patient's history as important).
2. After a detailed History (containing Observational evidence), the physician lists the clinical and laboratory findings (Evidence).
3. The clinician must next list the *Differential Diagnosis*, a list of *all* diseases (hypotheses) that might explain the chief complaint and the observations.
4. Finally, there should be a list of further tests (Experiments) still needed to rule out (or rule in) some of the diagnoses. **The skill of the clinician is shown by the efficiency of the tests (observable evidence) that rule diseases in or out.**

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The significance of this parallel between Differential Diagnosis and Stronger Inference is that Medical School Faculty can compare a Clinician's use of Differential Diagnosis with that of the Scientist using Stronger Inference. In this way, the use of Stronger Inference within Knowledge-Step Forums for improving Medical Knowledge can become part of Medical and Surgical Post-Graduate Education, and encourage evidence-based "scientific evaluation" of diseases and treatments.

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The aphorism "Stronger Inference sharpens the cutting edge of science" will be readily demonstrated when it is being used in K-Step Compendia, where it will become a natural part of the Compendor's thinking while developing a Knowledge-Step Forum. This is one of the ways that Knowledge-Step Forums (and their associated K-Step Compendia) can make an important contribution to Post-Graduate Education in *both* Science *and* Medicine.

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Tools.5 Variations on the MultiLevel-Format

Note that the MultiLevel Format is applicable *to many different overall teaching patterns*, including many in Medicine, as shown in Fig. 4. Thus, should some Compendor find that MultiLevel Format described above does not suit what is needed for some Narrow-

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Topic, a change in the meanings of the sections or levels may make the Format useful.

What is *most important* is that *the presentation be useful* to the contributing experts, as well as to the ultimate Readers.

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Fig. 4 (Title): Some of the different expansions possible in a MultiLevel Format.

General → Specific (Generalization to Examples)
 Specific → General (Instances to Generalizations)
 Non-quantitative → Quantitative
 Content → Critique
 Descriptive → Analytic
 Analytic → Descriptive
 Theorem → Proof
 {Medical} Symptom / sign → Differential Diagnosis
 {Medical} Diagnosis → Alternative Rx → Complications
 {Medical} Presentation of illness → Disease Progression → Complications
 {Medical} Event → Consequences
 {Medical} Disease Hz & Rx → Critique (Clinical-Pathology Conference)
 {Medical} Rx → Appropriate and Inappropriate Usage
 {Medical} Novice → Advanced

Fig. 4 (Legend): The MultiLevel Format is applicable to many teaching situations. The list here is not exhaustive, but only intended to show the large range of applicability of the MultiLevel Format.

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Tools.6 The MultiLevel-Format as an aid to *writing and comprehending*.

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The design of the Compendium-Format has *two mutually-reinforcing* goals:

1. To be *easy to create* (by concentrating on the basic "structure", *i.e.*, the core ideas of the Narrow-Topic; and by organizing the presentation in a MultiLevel Format).
2. To be *easy to comprehend* (by the simplification derived from concentrating on the basic "structure", and by using the MultiLevel Format).

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The process of writing in a MultiLevel-Format is very similar to, and has the strengths of,

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the method of "writing a paragraph", as is commonly taught in high schools and colleges (here paraphrased): "At first, tell them what you will tell them; then tell them." What this does is force the Author to organize the presentation so that the "summary sentence" (aka "thesis sentence") is the *first* Sentence the Reader sees in the paragraph. In order for the Author to compose such a first-Sentence, the Author must mentally go through the *contentions* that will be presented, and summarize them in his/her mind. *That summary becomes the first Sentence.* This same procedure is *an essential part of writing in a MultiLevel Format.*

This thought-process ensures that the goal of the paragraph is clear to both the Author and the Reader.

What the MultiLevel Format provides **additionally for the Author** is the ability to easily categorize the "contentions" into Levels, and indicate those Levels to the Reader. As described by Jewett [1981] in his article on "Multi-level writing in theory and practice", a **standard presentation** is *linear*, requiring *every* Reader to follow the *same path* through the material. *Any material that is secondary* to the main theme will *interrupt the linear flow of the ideas*. So, in writing in a linear-presentation-mode, considerable author-time is devoted to finding a way, within the linear-text, to express the relative importance of *secondary material*. The Author wastes considerable time trying out many phrases, such as "However, . . .", "On the contrary,...", "Despite ...", *etc.*

In marked contrast, the **MultiLevel Format** has a *parallel* presentation, where the Reader can immediately understand that the *secondary material is secondary*, by means of the typographical method chosen by the author to indicate different levels. So, the author can easily add secondary material just by shifting that material to a different level, without needing to add phrases to alert the reader.

*MultiLevel writing is both faster and easier. Faster and easier for the author to write **AND faster and easier for the reader to comprehend.***

The ease of writing in an MultiLevel Format was confirmed when Jewett & Rayner wrote an entire textbook in this style [Jewett1984]. Both authors, each very experienced in technical writing, found it *much easier* to write in this format.

And the students, who gave detailed comments about the content, reported it was *much easier to learn* in the MultiLevel Format.

Tools.7 The MultiLevel-Format mimics the Knowledge-Path

Another reason that the MultiLevel-Format *aids comprehension* is diagrammed in Fig. 5, where the multiplicative nature of the MultiLevel Format is depicted.

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Fig. 5 (Title): The multiplicative nature of MultiLevels in K-Step Compendia.

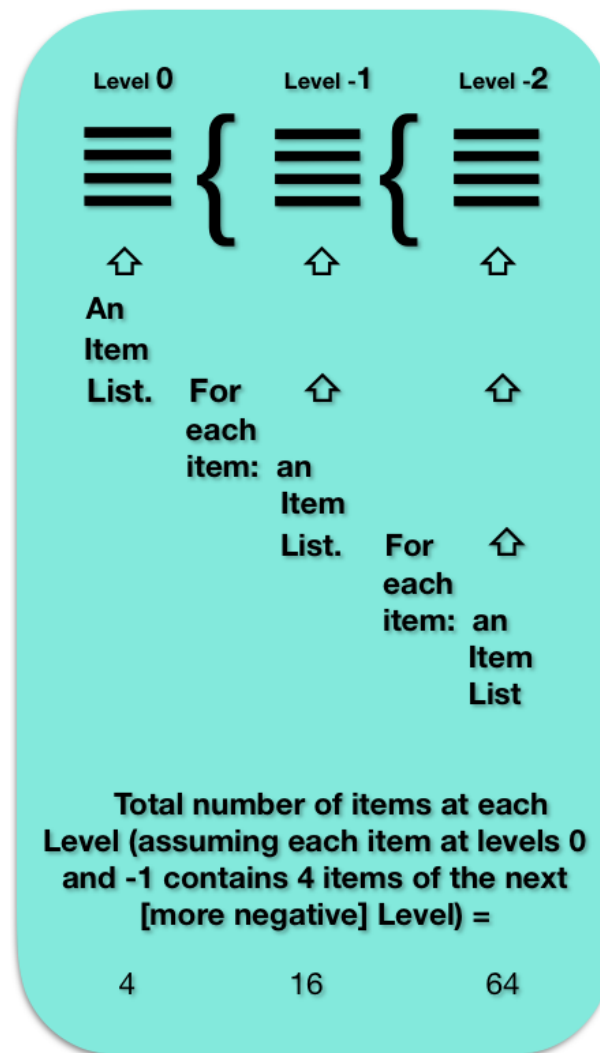


Fig. 5 (Legend): This diagram demonstrates what is *not* shown in Fig. 3: that the increasing Levels of the **MultiLevel Format** are multiplicative in number. That is, more and more *detail* is described when moving to the next lower level (to the more

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negative level number).

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In Fig. 5, the **horizontal lines** show *items* at three **levels**, *within a single Section*, such as "Assertions". For didactic purposes, let's assume for this figure that there are *four Assertions (shown just as horizontal lines at Level 0)*. Further, assume that the third Assertion has four other items in its List (as indicated by the large '{' symbol). In turn, the third item at Level -1, itself also happens to contain four other Lists at Level -2. When this sort of expansion occurs for *many* of the items of the Assertions Section, then the **total number of items at each Level increases as a multiple of the preceding Level** (as shown by the numbers at the bottom of the Figure).

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Notice also that the amount of *detail increases* when going to more negative Level numbers (left to right). Expressed differently, the evidence needed for a generalized Assertion at Level 0 is made up of greater and greater *detail* at Levels -1 and -2.

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Thus, when going from **RIGHT-to-left** in Fig. 5, one is moving from *lower levels (with more details) to higher levels (with more generality)*. This is in the same direction as "up" on the Knowledge-Path in Fig. 1 with respect to decreasing particularity and increasing generality.

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Said in a different way: when the MultiLevel Format is used, *the relationships within each Knowledge-Step* are analogous to the relationships *between* the Steps in the Knowledge-Path. Stated yet again in a different form: the *local* organization *within* each Knowledge-Step mimics the structure *within* the Knowledge-Path of Fig. 1.

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Within a step, each Assertion is an accurate summary of the material at lower-levels **within that Step**, just as a "higher-level" K-Step-Compendium (in Fig. 1) should accurately summarize the Knowledge of "lower-level" K-Step Compendia.

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The reason that this organization makes it "easy to comprehend" should now be clearer. A Reader of a K-Step-Compendium will find the "summary statements" first in each Step (just as in the "paragraph structure" advocated by our teachers).

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For the same reason, it is easier for the Knowledge-Compendor of a Knowledge-Step to evaluate how the Knowledge in **previous steps** will be incorporated (or modified) to go into the Step the Compendor is creating. This makes it easier for creation of the Knowledge-Path, which is a vital part of the process.

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In summary, the overall goal of K-Step Compendia is to organize information into

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knowledge so that it is easily accessible and understandable. The Knowledge-Path contains an organization such that moving up the path, the *generality of knowledge-structure becomes apparent, while the particularity of detail diminishes. The same organization occurs also within each Knowledge-Step via the MultiLevel Format.*

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Tools.8 Protecting posted submissions from plagiarism

Authors wish to be quoted, but *not* plagiarized. The difference between quotation and plagiarism is in the **attribution**: is the attribution correct or faked? A Chained Hash Algorithm can be used to establish which of two sources was first to publish on the Web. If a plagiarizer uses the algorithm, but fakes it to make the quotation appear to have been published earlier by the plagiarizer, the faking can be demonstrated by the Chain of Hash-numbers; the demonstration of faking cannot be refuted by a plagiarizer.

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Providing proof of authorship will be especially important in the "Conjectures" category of MultiLevel K-Step Compendia. Conjectures do not have sufficient evidence in their favor, and may well be rejected for publication in a paper-based publication-paradigm for that reason. Those who have such Conjectures are Senior Scientists or Clinicians, and Students just entering Post-Graduate Training, **and everyone in between!** These ideas are often hidden because **if they are made public, the attribution will be lost** (*i.e.*, it is highly-likely that plagiarism may occur on the good ideas). By offering a place where attribution will *not be lost*, Knowledge-Step Forums provide a means for **broader dissemination of "odd-ball" ideas, and hunches.** Realize that **some of these ideas and hunches will actually become the basis for progress in the field**, as has been shown repeatedly in the history of science!

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There ***should be*** several classes of scholarly recognition when new evidence brings about a change of knowledge in a field:

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1. Who thought of the idea, and when?
2. Who invented the method used to test and prove the idea, and when?
3. Who created the definitive evidence, and when?

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Presently only #3 presently "counts" in scholarship, despite that other scholars deserve credit for the ultimate result, which is due to cooperative effort. The use of a Chained Hash Algorithm in K-Step Compendia could certainly provide ***appropriate credit*** within the research enterprise, thus contributing to dissemination of potentially useful, but as

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yet unproven ideas.

Here is how the CHA (Chained Hash Algorithm) will work. A new contribution to a Knowledge-Step Forum (such as a comment, an annotated citation, a quotation, a section, *etc.*) is only permitted for those who have previously registered and provided name, contact information, and other MetaData, and have been verified by email. Automatic processing by the K-Step software, of a new contribution from a registered Author includes creating MetaData that identifies the Contributor as the Author of the contribution. Then, both the contribution and specified parts of the MetaData are concatenated together with a previously-chained hash-number, and the whole concatenation is then hashed yielding the CHA Hash for that contribution. The CHA Hash is then transmitted within the MetaLink MetaData, so it exists on multiple WebSites. This is a variant of "cipher block chaining" [Schneier1996, p.193].

A characteristic of such Hashes is that change of even a single bit in the concatenation will markedly change the Hash-number. While collisions (identical hash-numbers) can theoretically occur, they are *exceptionally unlikely, especially when the change in the contents of the concatenation is limited by actual names, and appropriate words of a language*. Any claim of a plagiarist to have published the contribution before the true Author can be rebutted by review of the published hash-numbers of both the Author and the plagiarist.

Since any errors in these hash-numbers might have a serious effect on an Author's career, mistakes (such as data-drop out) could be costly. Therefore, extra ECC (Error-Correcting-Code) is applied to the hash-numbers for storage and transmission.

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Tools.9 A Summary of the differences between a present-day Review Article and a MultiLevel K-Step-Compendium Guide-to-the-Literature

Fig. 6: Comparison of a *Review Article* and the new "Compended-Guide" (on **3** pages)

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Comparisons of $\Rightarrow \Rightarrow$ with respect to $\Downarrow \Downarrow$	Paper-based Journal Review Article	Online Journal Review Article	Online Compended-Guide: a K-Step-Compendium, with narrow-topic, in MultiLevel Format
Paradigm shift	No	No	Yes
Author's Academic Level	Senior Scholar (Faculty, Scientists, & Clinicians)	Senior Scholar (Faculty, Scientists, & Clinicians)	<i>All Scholars</i> , both Senior Scholars (Faculty, Scientists, and Clinicians), and those in training (PreDoc, PostDoc, Clinical Fellow, Medical/Surgical Resident)
Readership Limitations	Must be Subscriber or Library user	None: Open Access	None: Open Access
Reader's Cost	High	Low	Low
Author's Cost	Low	Moderate to high	Low
Typography by	Publisher	Author	Author
Facilities needed to make Review article public	Publisher, Subscribers & Libraries	Online Publisher; Fee support	Individual Scholar with access to WebSite server (Institutional [free] or Commercial [low fee]), using Knowledge-Step Forum Software

Comparisons of $\Rightarrow \Rightarrow$ with respect to $\Downarrow \Downarrow$	Paper-based Journal Review Article	Online Journal Review Article	Online Compended-Guide: a K-Step-Compendium, with narrow-topic, in MultiLevel Format
Peer review	Once	Once	Continuous; After Posting
Time before content is available	Often Many Weeks from review, delays waiting for space	Possible less review delay; some waiting for space	Immediate Posting; 1. Peer review occurs <i>after</i> posting; 2. No waiting for space
Can content expand with new info?	No (separate errata only)	Yes, by Revision	Yes.
MultiLevel Format?	No; <i>Linear</i> presentation	No; <i>Linear</i> presentation	Yes; Parallel format for a range of different Interests and/or Backgrounds
Efficiency for Developing a Bibliography	<i>Low</i> efficiency; Reader must access multiple WebSites; must choose Link-jump based only on standard citation to whole article	<i>Moderate</i> efficiency; Reader may need access to several WebSites; must choose Link-jump based only on standard citation to whole article	High efficiency; All information available online with these reader-aids: 1. Assertions with Evidence 2. Observations with alternative hypotheses 3. MultiLevel-Format helps to identify weak Assertions and additional research pathways 4. Contributions with correct attributions

Comparisons of $\Rightarrow \Rightarrow$ with respect to $\Downarrow \Downarrow$	Paper-based Journal Review Article	Online Journal Review Article	Online Compended- Guide: a K-Step-Compendium, with narrow-topic, in MultiLevel Format
Ancillary benefits	Author's reputation enhanced if Journal is highly ranked	Rapid Publication at times	<ol style="list-style-type: none"> 1. Self-organizes a community of like-minded scholars 2. Speeds knowledge creation 3. Actively teaches scholarly approach to problems 4. Each participant motivated by self-interest 5. Format helps placement in Knowledge-Path 6. Is "self-correcting" via continuous peer-review 7. Can be used to "make a mark" in one's field. 8. Creative Commons copyright with correct attribution 9. Automatic Hashes against plagiarism.

(no Fig. 6 legend)

Tools.10 The use of Knowledge-Step Forums for Preprint-Critiques

The Software for Knowledge-Step Forums is designed for collection and display of *peer-reviews* of scholarly work by Compendors. Another means of obtaining *peer-reviews* and critiques from experts is by means of a Preprint Publication on the Web. Such preprinting has a substantial history in Physics through the WebSite "ArXive". Pre-printing is just beginning in Biology and Computer Science via "PeerJ Preprints". Forum-Software can post the Article on its Website, and receive comments from registered viewers. The Author/Compendor can then reply, or modify the content, as appropriate.

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Thus, if the "peer-review needs" of scholars are not being met, then the Knowledge-Step Forum Software will provide an easy alternative.

An advantage of the Software for Knowledge-Step Forums for use in Preprinting is that *it provides protection against plagiarism* (see Tools.8). By this means the Chained Hash Algorithm will provide definite evidence of the date of posting.

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Tools.11 Speeding Publication via posting of Preprint Articles

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Just as the Knowledge-Step Forum Software can be used to post Preprints (see Tools.10), the Software can also be use to *post Articles* on the Web. As with Preprints, the advantages include protection against plagiarism (see Tools.8).

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Thus, an Author could post using the Knowledge-Step Forum Software initially for a Preprint-Critique, and then, after either replying to the Critiques or modifying the Article, the continued posting would essentially be a Web-based "publication" on an Active Archive, which can remain available until the Preprint becomes a Journal-Article, or until it is Archived elsewhere.

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KNOWLEDGE-COMPENDORS:

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Compendors.1 Who will be Compendors for Knowledge-Step Forums?

As evident above, the duties of the Compendor are several. Whom in Academe can we count on? Who will self-nominate for this activity when there are *always* grant deadlines and teaching responsibilities for faculty?

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This Article supports the Author's view of Post-Graduate Education, which is based on the following aphorism:

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A goal of "Training" is for the student to

"Learn *specific* responses for *specific* situations".

A goal of "Education" is for the student to

"Learn to devise *new* responses for *new* situations".

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A goal of "Post-Graduate Education" is for the student to

"Learn how to *Create Knowledge, by doing it*".

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In the Author's view the best candidates to be Compendors are **Post-Graduate Students at all levels**. There are several reasons for this statement:

1. These students are organizing information and knowledge *for themselves*, as part of the process of qualifying for a higher degree, or for a higher academic position.
2. These students have Thesis Advisors who can help them in their efforts to maintain a K-Step-Forum on a narrow topic.
3. These students will want to coordinate the *self-organizing community of like-minded scholars interested in the same narrow topic that will automatically occur as the Knowledge-Step Forum becomes known*. Such scholars have similar interests, may become friends and collaborators, and *may become sources of jobs* in the future. The community will be world-wide and not limited by the requirement to meet other scholars at expensive international meetings -- a huge benefit of the Internet/Web.
4. These students have grown up with computers, and with social networks based on computers, so Knowledge-Step Forums are just another part of their "computerized" life.
5. The bibliography resulting from a good Compendium could be an important part of the bibliography that is needed for a thesis.

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6. It is a unique opportunity to have one's research plans *peer-reviewed* both before and during the research.
7. It may provide a chance to "make a mark" in a field. The discussion (over which the Compendor has some control) can allow the Compendor to demonstrate competence by (offline) analysis of issues and publications. 705
8. K-Step Compendia may be listable on a C.V. in the future, if the Compendia are of good quality. 708

Specifically, what students are we talking about?

1. Pre-doctoral students studying for a Ph.D. in science, engineering, medical sciences, *etc.* These are Post-Graduate Students from a university's viewpoint. 711
2. Post-doctoral students *either* working on a topic related to their Ph.D., but with new techniques and/or mentors, *or* entering a field that differs from that in which they received their doctorate. 714
3. Post-MD students in Medical or Surgical Residencies.
4. Post-Residency Fellows in Medical or Surgical Specialties 717

The numbers of students in these categories are *large*. Here are some estimates:

1. Ph.D. students: The NSF (National Science Foundation) in April, 2015 listed total graduate students in Science & Engineering (excluding health) in the U.S. at over 500,000, with about 140,000 in their first year [NSF2015]. If we use the NSF first-year estimate and assume that 15,000 drop out, there would be about 125,000 new students per year. Since 50% of all students are above average, for this discussion assume a number of 62,500 above-averaged Ph.D. students each year will become Forum-Compendors. 720
2. Post-Doctoral students: NSF listed over 40,000 postdocs in [NSF2015]. There is no estimate of the duration of the PostDocs. If we assume a 4 year duration, there would be 10,000 new PostDocs per year. Since all are above average (continuing for a Post-Doc is *not* average), let's assume they all become Forum-Compendors. 726
3. Post-MD's in Residencies: The AAMC (American Association of Medical Colleges) estimated in 2013 the total physicians in Residency positions was over 116,000, with 28,500 in 1st year (average duration of 4.1 years) [AAMC2015]. It is common at many Medical Schools for Senior Residents to provide a Seminar on an advanced topic at least once in the Residency; regrettably this work is rarely published, even though many are considered by the faculty to be of high quality. 732
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Assuming that (the above-average) 50% of the Senior Residents were Compendors, then there would be 14,500 Knowledge-Step Forums in this group.

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4. The total number of above-average possible Knowledge-Step Forum Compendors in the above three groups is **87,000 per year** (62,500 + 10,000 + 14,500).

What has *not* been estimated in the number above are the following:

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1. The number of students in any of the categories who study *outside of the U.S.* Science is international in scope and geography. Good students in other countries will become Forum-Compendors for the same reasons as U.S. students do.
2. Scholars with research experience but are not presently active in research, such as Emeritus Professors, Investigators whose grant applications were not funded (80% of applications!), and those, though having research training, are working where research is not possible.;

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If we allow a number of 13,000 per year to cover the last two categories, an order-of-magnitude estimate for the total number of possible Forum-Compendors *per year* when each Compendor creates only one Compendium, could be **100,000**, which is about 274 per *day*. While this is a large number, it is dwarfed by the estimate of **5,000** peer-reviewed **articles** that were published **each day** in 2011 (1,800,000 per year) [Outsell2013].

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Conclusion = There is plenty of material for Compending, for all!

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Compendors.2 How will Post-Graduate Students communicate with experts?

The neophyte Compendor need not be anxious that her/his expertise is insufficient for the job. Consider these reasons:

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1. In reality, the Editor of a Journal does not know everything about which the Journal accepts articles. The Editor depends on the Reviewers for expert opinion, while the Editor *need only be able to read and understand the reviewers comments, but not the exact details.*

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Similarly, the Compendor of a Knowledge-Step Forum, in order to be effective, need only have a general understanding of the materials submitted, since this will be

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- sufficient to deal with comments from a Contributing Expert. If mistakes are made, the Experts and Readers will bring them to the attention of the Compendor; this is the method by which "peer-review" improves publications. 771
2. The Compendor, who is still in training, will have a Mentor available for advice, either a PhD Thesis-Advisor, a Project supervisor, or a Senior Clinician. These Mentors, who are named in the Compendium, will want the Compendium to be of high quality, since it comes from her/his lab and/or institution. Consequently, Mentors are likely to look carefully at what the Compendor does. 774
3. The non-expert Compendor can start a Compendium by doing a literature search and then quoting from the literature. The Compendor need not express an opinion, but rather, can let others (in the literature) speak. In this way, it is the quoted author who "makes a claim", not the Compendor. For example, imagine that the Compendor finds this quote in the literature: "Experiment Q by Dr. R has not resolved this issue." This can be put into the Knowledge-Step Forum, and if others disagree, then the arguments will also make the Knowledge-Step Forum an interesting WebSite. Indeed, the Compendor can write to Dr. R and say "I'm creating a Compendium related to your work, and I've found this quotation. Would you care to comment?" The probability of receiving a reply is very high. In this way, the Compendium can be built up, even by a neophyte Compendor. 777 780 783 786

Compendors.3 Will experts review and contribute to Knowledge-Step Forums?

It is reasonable to be concerned about how much time academic faculty will be willing to spend on "yet-another job", busy as they are both writing grants and teaching. 789

However, *self-interest is a powerful motivator*:

1. The Expert wants to be sure that **her/his work is quoted correctly**. 792
2. The Expert wants to ensure that the **limitations in the work of others is described accurately and completely**.
3. The Expert wants to **increase readership** of his/her work. Citations in Knowledge-Step Forums and K-Step Compendia to the Expert's publications will collect new Readers. 795
4. The Expert wants to **increase the quantity** of what the Expert has "given away". Academia is a "Gift-Culture" where prestige is determined by the quantity and quality of what is given away (such as time, energy, creativity, expertise, and knowledge) [Raymond2000]. 798 801

- Note that the recognition of the Compendium-Submission is by the *group of like-minded* scholars who have been automatically assembled during the Knowledge-Step Forum-Process. **Lack of participation may be noted almost as easily as participation.** 804
- Experts will be encouraged to provide skilled, helpful reviews because the Expert's "peer-review" comments or additions *are available in the Compendium, to be read and judged by the expert's Peers!* Such "Meta-PeerReview" does not occur in the paper-publishing paradigm (a major failing because of the [growing?] misuse of confidentiality in peer-review or articles and grants). 807
5. The Expert *wants to be quoted*, but *not* to be *plagiarized*. The Creative Commons basis of K-Step Compendia encourages quoting, but does not guard against plagiarism. However, the Knowledge-Step Forum's regular use of the Chained Hash Algorithm means that the correct authorship of the Expert's statements can be proven at a later date. By the nature of the Chained Hash Algorithm, the plagiarist cannot deny the plagiarism. The algorithm was described in Tools.8 (above). 810
6. The review of the content of a Knowledge-Step Forum by like-minded scholars is a *form of post-hoc peer-review*, but it is not the usual "vanilla-flavor" of present peer-review in which the reviewer is a "gate-keeper" for publication of articles or funding of grant applications. K-Step peer-review differs from the present "old-boys network" peer-review in the following ways: 813
- 1) Reviewers are not chosen by an Editor, but are either contacted by the Compendor based on a reviewer's contributions to the literature, or are self-selected. Thus, unconscious gender-bias is less likely, and the accuracy of the match of expertise to content is likely to be greater. (Editors do not know all of the "players" in rapidly changing fields.) 816
 - 2) Reviews are more likely to involve continued communications between the forum-contributors and reviewing commentators; such prolonged communications may well aid development of a field. 819
 - 3) The contributors and commentators start on a more-equal basis in K-Step Forums, in contrast to the applicant/judge relationships engendered in the search for errors and "quality" in present peer-review. 822
 - 4) Reviews and the contributor's replies are published, with all authors fully identified. This is being added to some current peer-reviews, but is an integral part of Forum-ethics and the Forum-format in K-Step Compendia 825

development.

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- 5) The "review" in K-Step Forums is likely to be shorter and not be as great a time obligation on the part of the Reviewer because the large "responsibility" for acceptance or rejection is not present in reviews for K-Step Forums. Moreover, review in K-Step Forums involves different content from the traditional "last review before publication", and can range from conjectures at the start of a project, to evaluation of preliminary data. This also reduces the pressure on the reviewer for a "complete, thorough" review. In addition, the reviewer can submit contributions several times, as the debate ensues online.
- 6) The automatic hashing of contributions to reduce plagiarism will tend to reduce plagiarism by reviewers.
- 7) As quoted by Rennie [2016], a commentary of journal reviewers by Bailar & Patterson stated, "The arbiters of rigor, quality, and innovation in scientific reports" did not "apply to their own work the standards they use in judging the work of others." [Bailar 1985]. Such a bias is less likely in K-Step Forums because reviewers will realize that their own (public) words of criticism in one Forum may be easily quoted back about their own work in later Forums.
- 8) The automatic integration of peer-review into Web-based Compendia will provide a mechanism by which a variety of peer-review methods will be created and used. A Compendor may structure the Forum's peer review for specific purposes related to the topics covered, or other factors. Such a varied "peer review" experience might later inform continuing efforts to revise or devise peer-review mechanisms useful for Knowledge-Creation.

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See Fig. 7 for further comparison of Compendia-Review and Present Review methods.

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Fig. 7 (Title): Comparison of two types of Peer-Review for evaluating publication

Type of Review ⇒ Review characteristic ⇓	Present-day Pre-Publication Peer-Review	WebCompendium Peer-Review
When?	Only just before "publication"	Repeated reviews starting before Preprints and continuing after official Paper Publication or Web-posting (even encouraging correction of errors <i>not known until a later time</i> ; publishing on the web allows for corrections, additions, and comments to the original article-- a <i>major benefit to readers</i>)
By whom?	One or two reviewers known to the Journal editor	Peer-scholar experts and motivated readers (of any background)
Are Reviewers experts in the specific field?	Sometimes, sometimes not (Journal Editor may not know experts in all fields, especially new ones)	Always, due to Author/Compendor knowing the literature of the field and requesting review from the experts
How detailed are reviews?	Depends upon Reviewer and Editor; may lack detail important to article's conclusions	As detailed as necessary for Author (who can request more detail, as needed)
Reviewers identified?	Often not (if not, then transparency is lacking)	Always (except for contentious topics that might lead to academic or economic reprisals)
Can Author contact Reviewer for further info?	Generally not, especially when Reviewers are not identified	Always, since Author/Compendor is easily in email contact with all Reviewers and Contributors
Reviews made public?	Usually not	Always
Are reviews reviewed?	Only by Editor, and by Author (in reply to Editor)	Always, Reviews and comments on reviews are available to all readers
Review of Preprint?	No	Always

Fig. 7 (Legend): The WebCompendium Review via online Forums has many benefits over older methods of Peer-Review.

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Compendors.4 What will ensure the quality of K-Step Compendia?

- There are a number of factors that should *sustain the quality* of K-Step Compendia, even though there is no *central control*: 870
1. The Compendor's reputation will be affected by the quality of his/her Knowledge-Step Forums. This means that there should be strong motivation for the Compendor to do a good job. 873
 2. Since all Submissions are automatically saved, any critical comments will need to be dealt with in some way, thus increasing the quality if the criticisms are useful. 876
 3. If K-Step Compendia of poor quality do appear, a WebSite running the Software "SlashDot" can be used to provide Readers with evaluations of K-Step Compendia so that lower-quality K-Step Compendia can be avoided. SlashDot is a well-developed method by which evaluations by many "reviewers" can be organized and presented, and where *the reviewers themselves are rated for quality and consistency*. **Automatic Meta-PeerReview via the Web!** 879
 4. Recognize that even a low-quality K-Step Compendia may be better than *nothing*. So, time spent in finding that a Compendium is not useful, may not be fully wasted; some new References may be found. 885
 5. A path for those who have **major** disagreements with a given Compendium (e.g., when the Compendor hinders or prevents contrary views in discussion) is as follows: Since K-Step Compendia can be copied and published elsewhere (with correct attribution), it is feasible, under such an extreme situation, to copy an existing Compendium, make changes that are felt necessary (with new attribution of the changes added to the prior attributions), and to place the modified Compendium on the Web in a new Knowledge-Step Forum. Note that copying and re-publishing a Compendium will be plagiarism if the original Compendium is not given correct attribution, as can be proven by the Chained Hash Algorithm (Tools.8, above). Such "forking" is common in software projects involving many volunteers, and does not stop collaborations among developers. 888
 6. A "built-in" feedback mechanism that will improve Knowledge-Step Forums and K-Step Compendia, occurs as Users communicate to Compendors about problems. New Users and Programmers may make the system better by adding to the Software when it is published as Open-Source. 891

Compendors.5 The multiple roles of Knowledge-Step Forums in a scholar's career

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As described in this Article, Knowledge-Step Forums can play multiple roles at different stages in the careers of scholars.

1. Initially a Post-Graduate Student could use a Knowledge-Step Forum to help delineate an area of research that is promising for an Article or Thesis. 906
2. During the research, a Knowledge-Step Forum could help a Post-Graduate Student to obtain comments and advice from experts other than the student's thesis advisor. 909
3. As research results became available, the Post-Graduate Student could use a Knowledge-Step Forum to obtain Preprint-Critiques. 912
4. While waiting for acceptance from a Journal, a Knowledge-Step Forum can become a form of Open-Access "Publication" on the Web, with commenting available.
5. As an Academic Career develops, there will be repeated need for Knowledge-Step Forums to study new areas, or new aspects of an area, for publications and grant applications. 915
6. Each of these Knowledge-Step Forums provides the Compendor with the opportunity to have two-way written communications about technical topics with Experts in the field. This is a personal advantage that is needed *throughout an academic career*. 918 921

DISCUSSION:

Much of the Discussion has been included in the parts above (*q.v.*). Here are a few additional comments:

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A List of the Principles that have governed the Software design, includes:

1. All software must be Intuitive-to-use for present Web-Users (*i.e.*, no manuals needed, though online Help should be available for new users). 927
2. The Software must be compatible with existing Browsers and Word-Processors.
3. Centralized administration or support must not be required (after software development and distribution). 930
4. Forums and Compendia will be Open-Access.
5. All code that is supported by volunteers will be Open-Source. 933

6. Knowledge-Step Forums will be able to adapt, over time, to changes in scholarly needs, interests, and trends.

While the long-term plan is that neither Central Support nor Central Control will be needed, initial support is absolutely needed to provide the necessary Software. After release of the Software, there may be need for additional financial support for the following:

1. A WebSite to host a SlashDot program to evaluate posted Compendia, and to "GreyList" poor Sites.
2. A WebSite to provide CHA seed numbers until minimum requirements for adequate security are met in other ways.
3. A WebSite where volunteers can provide additions/changes to Open-Source Software as continuing improvements.

It is worthy of note that there is an academic area called "Knowledge Synthesis" that studies methods to merge data and results across multidisciplinary fields, seeking to elucidate optimal Knowledge-Synthesis methods for particular research questions, both qualitative and quantitative. Some of the recommendations available at the time of writing this "Compendium" article have been organized into a Figure and Tables [Kastner2016]. Also see the article's Appendices. Both article and appendices may well be of practical help to Compendors.

In order for the Internet to be an efficient searchable repository of current and developing knowledge, one additional feature will be needed: In any given publication, ForwardLinks must be available, *within the publication*, to those articles that, in the future, cite the given publication, as fully described in a Supplement to this article. Such links are presently handled commercially, for profit, by the Web of Science. Coverage is not complete. In addition, this database and method has been sold recently. *There is no certainty that commercial entities will fulfill the internet-needs of scholars indefinitely into the future.*

- . A solution is development of Open-Source Software that facilitates the citing of one website by another. Such software is fully described in the Supplemental File of this Preprint (The ForwardLink-Protocol); it was a Supplement to Versions 1-4, but not to Versions 5-12. ***This Protocol includes many enhanced features especially for scholarship.***

Open-source software for this functionality should be on all Web-servers that contain scholarly articles, so as to make the WWW a distributed knowledge repository.

CONCLUSION:

What scientist would not wish to reach into the present fount of information/knowledge to obtain a portion of the cool, clear water, presently shooting with cannon force out of a firehose at more than 5,000 articles **a day**? That was in 2011! How many firehoses are there today? 969

Extending the metaphor, the firehoses are spraying the top of a giant iceberg where only the top 10% of 114,000,000 articles per year stay above the level of the sea. Active scholars search around the top using keyword searches and looking at "the best" journals, while the vast majority of the stored information/knowledge is soon frozen, inaccessible under the cold water. 972 975

Is our Knowledge increasing? Yes, but not in proportion to the "flow" of the firehoses, but only in proportion to a numerical increase in Specialists utilizing just a small part of the information that has been produced. *Knowledge-creation* requires *more than research papers*; it needs multiple, integrated Knowledge-Steps. 978

Contemplation of this situation should lead us to conclude that **the present internet paper-publishing model is failing us**. No solutions, public or private, are on the horizon. 981

In this context the idea of Knowledge-Step Forums is offered as the basis for creating a *new form of peer-reviewed "Compended-Guide" to the Literature, in a MultiLevel Format* (Knowledge-Step Compendia). A multitude of Forum-Compensors (pre-docs, post-docs [Nature2016], and medical/surgical residents) can be aided by their mentors and online experts to create peer-reviewed K-Step Compendia. *All participants in this work will be motivated by their own self-interest*. The Software for Knowledge-Step Forums can also be used to speed publication by Publication Preprints with online "peer-review" comments. 984 987 990

The new method to aid Knowledge-Creation, Knowledge-Step Forums, will be:

1. Adaptable to the needs of users; 993
2. Widely-available;
3. Used easily by all participants, each of whom is motivated by self-interest;
4. Without need for continuing financial support, after the start; 996
5. Used to improve student-roles in Post-Graduate Education;
6. Useful even on *big* icebergs.

SOFTWARE AVAILABILITY:

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At present no Software is ready to be released. We have programmed various "proofs of principle" to show that the goals can be achieved with Software additions to one Content Management System: the TikiWiki Content Management System Groupware. We have determined that a consistent, easy to use format can be accessed, modified, and controlled by available word processors. We now know that the TikiWiki "Forum" mode can be modified to allow all of the other procedures described here, including all restrictions that must be included.

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Readers can check www.info.webcompendia.org to find the current status of the project, and when versions may be available for beta-testing or regular use.

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COMPETING INTERESTS:

The Author is the Research Director, and majority stock holder, of a small business, Abratech Corporation. He is also the Principal Investigator on the small-business NIH grant that has supported this effort so far (see next section).

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There are no other Competing Interests.

1014

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REFERENCES:

1029

AAMC 2015. <https://www.aamc.org/data/421322/tableb2.html> accessed Sep10, 2015.

Bailar JC, Patterson K 1985: "The need for a research agenda." *N.Engl.J.Med*: **312**:654-657, 1985.

1032

Bjork B-C, Roos A, Lauri M. 2009. "Scientific journal publishing: yearly volume and open access availability." *Information Research* **14(1)** paper 391.

<http://www.informationr.net/ir/14-1/paper391.html> (accessed Oct21, 2015).

1035

Chamberlin TC. 1897. *J. Geol.* 1897; **5**:837. as quoted and cited in Platt1964.

Galbraith DW. 2015. "Redrawing the frontiers in the age of post-publication review."

Frontiers in Genetics **6**: art198; doi: 10.3389/fgene.2015.00198; Open-Access at

1038

<http://journal.frontiersin.org/article/10.3389/fgene.2015.00198/full>

(accessed Apr17,2016).

Hardin, G. 1980. *Promethean Ethics: Living with Death, Competition, and Triage*. pp.3-5.

1041

Seattle:Univ. of Washington Press.

Jewett DL. 1981. "Multi-level Writing in Theory and Practice." *Visible Language* **15**:32-40.

also at <http://repositories.cdlib.org/postprints/1547> (accessed Sep25, 2015).

1044

Jewett DL, Rayner MD. 1984. *Basic Concepts of Neuronal Function*. Boston:Little Brown.

ISBN: 0-316-46310-8; also at <http://www.escholarship.org/>-6f73v7rf>

(accessed Sep25, 2015).

1047

Jewett DL. 2005. "What's wrong with single hypotheses?" *Scientist*. **19**(21): 10. PMID:

PMC2048741; NIHMSID: NIHMS30352; also at

<http://www.pubmedcentral.gov/articlerender.fcgi?artid=2048741>

1050

- (accessed Sep25, 2015).
- Kastner M, Antony J, Soobiah C, Staus SE, Tricco AC 2016. "Conceptual recommendations for selecting the most appropriate knowledge synthesis method to answer research questions related to complex evidence." *Journal of Clinical Epidemiology* **73**:43-49. [http://www.jclinepi.com/article/S0895-4356\(16\)00105-0/abstract](http://www.jclinepi.com/article/S0895-4356(16)00105-0/abstract) (accessed Aug9, 2016). 1053
- Khabisa M, Giles CL (2014) "The Number of Scholarly Documents on the Public Web" <http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0093949> (accessed Aug11, 2016) 1056
- Knowles 1997. Pascal, B. Letters 4, p. 247 in Knowles E, ed. *The Oxford Dictionary of Phrase, Saying, and Quotation*. Oxford: Oxford University Press. 1059
- Nature 2016. "Frustrated postdocs rise up" *Nature* **530**:505, 25 Feb. 2016. 1062
- NSF 2015. <http://ncesdata.nsf.gov/gradpostdoc/2013/> accessed Sep29, 2015.
- Outsell 2013. Outsell consulting firm, as quoted by Noonan RV. "Open access: The true cost of publishing" *Nature* **495**:426–429 (28 March 2013) doi:10.1038/495426a (accessed Aug11, 2016) 1065
- Platt JR. 1964. "Strong Inference." *Science*. **146**:347–353, 1964.
- Raymond ES. 2000. "Homesteading the Noosphere." 1068
- <http://catb.org/esr/writings/homesteading/homesteading/> (accessed Oct21, 2015)
- Rennie D. 2016 "Make peer review scientific." *Nature* **535**:31-33, 2016.
- Schneier B. 1996. *Applied Cryptography, 2nd Ed*. New York: Wiley, 1996. ISBN 0-471-12845-7. 1071