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Abstract

Learning to read and understand research articles (primary literature) is an important step in the enculturation of higher education students into the scientific community. We presume, based on ideas from the field of genre analysis, that it is important for the development of reading skills to become conscious of the rhetorical structures in research articles. So, we determined how well science students are able to identify two important elements of this rhetorical structure: conclusions and grounds. First-year undergraduate life science students who followed a course called 'Biomedical Research' made assignments in which they had to identify these two elements. We analysed the answers of 20 students in detail and compared their answers with two expert readers. Furthermore, we conducted task-based interviews with four students to gain more insight in their reading strategies and to determine how they identify conclusions and grounds. Our results show that students and experts defined conclusions and grounds in different ways. Students and experts agreed on the most important conclusion of the articles. However, students identified a wide range of sentences which were not seen as conclusions by the experts. The grounds students mentioned mostly matched with their conclusions. Students sometimes failed to mention important grounds for a particular conclusion. In conclusion, our study shows the differences between student and expert readers of primary literature. Based on our results, we formulated criteria for the design of a teaching strategy that aims to improve students' skills for reading primary literature.

Keywords: argumentation, biology education, genre analysis, higher education, primary literature, rhetorical moves, science reading

Comment [EVL1]: Added an abstract and keywords.

Introduction

The research article, the most common type of primary literature, plays a pivotal role in the communication of scientific ideas. Due to the internet and electronic databases, scientists have nowadays easy access to a rapidly growing amount of research papers. Consequently, this has influenced their reading habits. Surveys indicate that the average number of article readings per scientist has increased. In 1993, scientists read on average 188 articles per year. In 2005, this number rose to 280 articles per year (Tenopir, 2009). However, the total time spent on reading primary literature has only increased marginally. Therefore, it is more important than ever for scientists to develop skills that will enable them to read research papers in an efficient way.

Holliday, Yore, and Alvermann (1994) have compared science reading with science learning:

Both science reading and science learning can be described as an interaction between prior knowledge, concurrent experience, and information accessed from print and other sources in a specific social context that is focused on constructing meaning. Readers interactively process information by switching between selective perceptions of text-based information (print, charts, pictures) and concurrent experiences (concrete inquiries, discussions, thinking) and comparison of the information and experiences with their personal knowledge (topic, domain, scientific enterprise, textual, strategic (p. 879).

Therefore, readers need specific skills for understanding science texts. Learning the language of science is an important step in the enculturation of students into the scientific community. However, mastering the complex skill of reading and understanding research papers is not easy for the novice reader.

Fang (2005) describes a number of characteristics of the language of scientific text

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10 (research papers or textbooks) which can cause reading difficulties with inexperienced readers.
11 Firstly, scientific writing has a high density of information. Sentences often contain a high
12 number of nouns and extended noun phrases. This is an efficient way of communication, but it
13 also may lead to confusion, because the syntactic clues which specify the semantic relationships
14 between the nouns are left out (Gross, Harmon, & Reidy, 2002). Secondly, scientific writing is
15 often abstract. Concrete experiences are turned into abstract entities via the conversion of verbs
16 and adjectives into nouns. For example: 'wheeze and become short of breath' are synthesised
17 into 'asthma attacks'. This process, called nominalization, can 'create problems for readers,
18 because it tends to neutralize or obscure meanings and construct an ideology that is often not
19 transparent to naïve readers' (Fang, 2005, p. 340). Thirdly, scientific texts contain a high number
20 of technical terms. Students who are not familiar with these specialised terms will struggle with
21 comprehending the text. Fourthly, scientific writing is authoritative. Authors try to distance
22 themselves from the text, e.g. by avoiding first person references. This can alienate students, who
23 are often used to more personal and informal texts.
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38 In addition, students are mostly used to textbooks, which 'are written mainly to deliver
39 agreed-upon, objective facts to a student audience. The main task for readers is to understand
40 straightforward factual statements' (Gillen, 2006, p. 34). In contrast, research articles are
41 persuasive (or argumentative) by nature (Gillen, 2006; Yarden, 2010). Experimental data is used
42 to convince other readers that the presented conclusions are justified. This process of persuasion
43 plays an important role in science: scientists are constantly justifying their claims (and attacking
44 counterclaims) in papers, on conferences, during lab talks, and so forth. The claims forwarded by
45 scientists do not speak for themselves; acceptance in the scientific community is strongly
46 dependent on the used rhetorical means. For example, authors of research articles use often so-
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10 called hedges: words like ‘may’, ‘might’ or ‘possibly’, which indicate the uncertainty of
11 statements. As Hyland (1998) remarks:

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13 Hedges are a crucial means of presenting new claims for ratification and are among the
14 primary features which shape the research article as the principle vehicle for new
15 knowledge. Hedging enables writers to express a perspective on their statements, to present
16 unproven claims with caution and to enter into a dialogue with their audiences (p. 6).

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18 To fully understand a research article, one must have a firm grasp of these intricate
19 semiotic constructions. Therefore, it is important that students in higher education who aspire to
20 be scientists, learn how to read research articles. Furthermore, understanding how research
21 articles are organized can give students more insight into scientific argumentation.

Comment [EVL2]: Removed the term ‘rhetorical structure’.

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23 Argumentation should be an integral part of science education (Jiménez-Aleixandre & Erduran,
24 2008) and reading research papers could contribute to achieve this aim. However, developing
25 students’ reading skills is a great challenge for educators, due to the beforementioned
26 characteristics of research articles.

Comment [EVL3]: Replaced “be a promising method” with “contribute”.

27 28 29 30 31 32 33 34 35 36 37 38 39 40 **Literature review**

41 42 **Reading strategies of scientists and science students**

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44 Bazerman (1988) has probably published the most extensive study on the reading strategies
45 of scientists. He interviewed seven physicists about their reading strategies and observed four of
46 them while reading articles. Bazerman found that the physicists read articles *selectively* (reading
47 not all parts of an article). Often they skip whole parts of the text, only reading the newsworthy
48 parts. What was considered the news depended on the interests and purposes of the scientist. For
49 instance, if the reader was very familiar with the topic of the article, he tended to skip most of the
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10 text and only stopped at new techniques, tricks or equations. Furthermore, the physicists read
11 articles *non-sequentially* (not reading the parts of an article in order). They often read backwards
12 and jumped back and forth (when, for example, a certain section raised questions about an earlier
13 one). These results were confirmed in a similar study by Berkenkotter and Huckin (1995).

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18 Additionally, Bazerman (1988) describes that scientists may read articles with two different
19 purposes. If they only want to extend their background knowledge, they tend to read less
20 critically. On the other hand, if they want to mobilise parts of the article for their own work, they
21 read in a much more critical way. They are, in other words, *evaluating* the article. Bazerman
22 describes how this takes place. For example, when trying to determine the reliability of an
23 article, scientists looked at the internal evidence and the style.

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30 According to Bazerman (1988), the reading strategies of scientists are very much
31 dependent on what he calls the 'purpose-laden schema'. This is a 'personal map' of the field,
32 which 'provides the framework against which the reader comes to understand an article. The
33 reader will process information that has significance for the existing schema and will view that
34 information from the perspective of the schema' (p. 243). So, the purpose-laden schema will
35 influence how readers approach an article. Bazerman's results correspond with a study by
36 Charney (1993), whose research suggests that scientists read articles rhetorically: '...they read as
37 is convenient for their own purposes (they read parts selectively and out of order); they weigh the
38 plausibility of claims and evidence; they struggle to understand unfamiliar technical terms; they
39 cheer and get mad' (p. 228). Furthermore, Charney found that graduate students tended to do no
40 more than understanding the text and integrate it with their prior knowledge. Brill, Falk, and
41 Yarden (2004) describe how novice readers (in this case high school biology students) try to
42 comprehend an adapted research article. They observed that students encountered a number of
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10 comprehension difficulties, probably due to a lack of schemas and automation (which expert
11 readers do possess). For example, one of their students was not able to create a coherent
12 understanding of the text when reading the Abstract. This is in contrast to expert readers, the
13 authors surmised: 'Expert readers can apply preformed schemas to construct the main outline of
14 the research that is about to be read from the abstract, although they have never read about it
15 before' (p. 508).

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22 Although these studies provide us with some insight into the reading strategies of scientists
23 and to a lesser extent of high school and graduate students, they contain almost no information
24 about how we can teach students to read primary literature in an effective way.

Comment [EVL4]: Replaced undergraduate with graduate.

Comment [EVL5]: Added "in an effective way".

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28 There are a number of interesting hands-on studies available on the use of primary
29 literature in colleges and universities (Jacques-Fricke, Hubert, & Miller, 2009; Janick-Buckner,
30 1997; Kuldell, 2003; Levine, 2001; Mulnix, 2003; Peck, 2004) but these are rather vague about
31 the reading skills of students. For example, students are asked in these studies if they feel that
32 they have become better readers. However, their changed perception does not necessarily mean
33 that their actual reading skills have been improved. So, there is a gap in knowledge regarding the
34 development of reading skills among students.

Comment [EVL6]: Removed "undergraduate".

43 44 Genre analysis

45 One possible and promising method to improve reading skills could be to increase the
46 students' understanding of the genre conventions of the scientific research article. Swales (1990)
47 defines genre as follows:

Comment [EVL7]: Removed an unnecessary question: "How can students turned into better readers of primary literature?"

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51 A genre comprises a class of communicative events, the members of which share some
52 set of communicative purposes. These purposes are recognized by the expert members of
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10 the parent discourse community and thereby constitute the rationale for the genre. This
11 rationale shapes the schematic structure of the discourse and influences and constrains
12 choice of content and style (p. 58).

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15 Swales (1990) argues that for the development of reading and writing skills it is important
16 for novice readers to become conscious of the rhetorical effects and structures of genre-specific
17 texts; they need to develop a rhetorical consciousness. Other authors have made the same point
18 as Swales (e.g. Cook & Meyer, 1988; Hill, Soppelsa, & West, 1982) although it has to be noted
19 that some authors are rather critical of this so-called 'genreist' approach. These opponents argue
20 that students should not be coerced into using stilted forms of text (for an overview of this
21 discussion, see Purcell-Gates, Duke, & Martineau, 2007).

Comment [EVL8]: Explained what we mean with 'rhetorical consciousness'.

Comment [EVL9]: Corrected an incomplete reference.

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30 The rhetorical structure of research articles can be described by analysing the rhetorical
31 moves in a text (Swales, 1990). A rhetorical move refers 'to a section of a text that performs a
32 specific communicative function. Each move not only has its own purpose but also contributes
33 to the overall communicative purposes of the genre' (Connor, Upton, & Kanoksilapatham, 2007,
34 p. 23). Swales himself has done some influential research on this subject. He analysed the
35 Introduction sections of research articles and discovered that they contain often the same moves
36 (Swales, 1981). Later on, he revised this model into CARS (Creating A Research Space), a 3
37 step-model which distinguishes the following three moves: Establishing a territory (e.g.
38 reviewing previous research), Establishing a niche (e.g. indicating a gap in knowledge), and
39 Occupying the niche (e.g. outlining the study's purpose) (Swales, 1990).

Comment [EVL10]: Added a reference about the use of the term 'rhetorical structure'.

Comment [EVL11]: Added a more precise definition of 'move'.

Comment [EVL12]: Added examples of moves.

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50 Probably due to their straightforward nature, genre analysts have not looked in great detail
51 at the Method section (with the exception of Kanoksilapatham, 2005). However, the Results and
52 Discussion sections were studied quite extensively. The rhetorical moves of the Results section
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10 (described by Brett, 1994; Kanoksilapatham, 2005; Thompson, 1993; Williams, 1999) can be
11 subdivided into two groups: presentational moves (i.e. data descriptions) and comment moves
12 (i.e. interpretations, explanations, comparisons). Dudley-Evans (1994), Peacock (2002), and
13 Kanoksilapatham (2005) have analysed the Discussion section. The former designated the
14 evaluation of results as the main part of the Discussion section and identified the following
15 moves in it:

Comment [EVL13]: Corrected a misrepresentation of the work of Dudley-Evans.

- 16 1) Information move: background information about theory, research aim, methodology, or
17 previous research.
- 18 2) Statement of result: presents a numerical value or refers to a graph or table.
- 19 3) Finding: observation arising from research; contains no reference to a graph or table.
- 20 4) (Un)expected outcome: comment on an expected or unexpected/surprising result.
- 21 5) Reference to previous research: used to compare results or as support for claim.
- 22 6) Explanation: reasons for an unexpected result.
- 23 7) Claim: a generalisation arising from the results.
- 24 8) Limitation: caveats about the findings, methodology or claims.
- 25 9) Recommendation: suggestions for future lines of research or methodology.

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42 Gross et al. (2002) characterized science as follows: 'To do science is to assert that a fact or
43 a theory is true of the natural world and to defend that assertion' (p. 187). That is why we
44 consider assertions and the evidence authors use to defend them, as the two central elements of a
45 research article to which we are limiting our research. We call –following Day (1998)- the
46 assertions in a research paper *conclusions* (although you may also call them claims or knowledge
47 claims), which correspond with Dudley-Evans' (1994) move 7. So, conclusions are
48 generalisations arising from the results. We call –following Toulmin, Rieke, and Janik (1979)-
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the evidence in a research paper *grounds*, which correspond with Dudley-Evans' (1994) moves 2, 3, and 5. The grounds described by Dudley-Evans (1994) are not exclusive to the Discussion; for example, findings and statements of result can also be found in the Results section.

Comment [EVL14]: Defined in a more precise way the terms 'conclusion' and 'ground'. Furthermore, we moved this section from the Aim to Genre Analysis.

Aim

In this paper we describe to which extent undergraduate students are able to identify rhetorical moves in research articles and compare their abilities with expert readers. Our subjects were first-year life science students who followed a course at the [name of institute] called 'Biomedical Research'. One of the main features of this course is the focus on reading primary literature. We decided to monitor the course and develop assignments, so we could get a clearer picture of the undergraduate students' rhetorical consciousness regarding primary literature. Furthermore, we compared students' performances with expert readers. The reading skills of these expert readers indicated to us the level which students ultimately should reach in their academic career.

Comment [EVL15]: Rephrased research aim.

Comment [EVL16]: Added a justification on the use of expert readers.

So, our research questions were:

- 1) Which types of statements in a research article do undergraduate life science students identify as conclusions and grounds and do these statements correspond with the statements found by expert readers?
- 2) Which textual features do undergraduate life science students use to identify conclusions and grounds and do these features correspond with experts?
- 3) What kinds of reading strategies do undergraduate life science students use when they read an research article and identify conclusions and grounds?

Comment [EVL17]: Replaced 'kinds' with 'types'

Comment [EVL18]: Slightly rewrote research questions 2 and 3.

With the answers of these research questions, we want to formulate criteria which can be used to design a teaching strategy that aims to improve students' skills for reading primary

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10 literature.

11 12 13 14 **Method**

15 16 **Educational setting**

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18 The data collection took place during a 10-week course called 'Biomedical Research',
19 which is part of the last quarter of the first-year program of bachelor life sciences at the [name of
20 institute]. The subjects of the course were related to physiology and pharmacology, in particular
21 the cardiovascular system. The course consisted of lectures, lab work, and tutor-led meetings.
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27 28 **Participants**

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30 The total number of participants which entered the course was 138. For the tutor-led
31 meetings, all students were randomly divided in twelve groups. The tutors were senior medicine
32 students and life science students. For our data collection, we randomly chose two tutor groups,
33 consisting of nine and eleven first-year students. Eight students were male and twelve students
34 were female. They were 18 or 19 years old. All students were novice readers of primary
35 literature and their native language was [language]. At the beginning of the course, these students
36 (minus one) filled out a questionnaire about their reading experiences regarding primary
37 literature. The majority of the students (thirteen) said they had read four to six research articles in
38 previous courses. Three students had read less than four articles and three students had read more
39 (up to seven-twelve articles).
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49 The two experts (called Expert A and Expert B) were a professor and an assistant professor
50 who both were lecturers of the course. They both frequently write research articles and are
51 experienced readers of primary literature in the area of cardiovascular research.
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Comment [EVL19]: Replaced
'panel of experts' with 'two
experts'

Intervention

Assignments. In this study we present the written answers to the three assignments of the abovementioned 20 students. These assignments were given in weeks 3, 4, and 5 of the course as homework and consisted of individually reading a research article and answering questions about the conclusions and grounds in the article. In each week a different research article was used.

The concepts presented in the articles had been discussed during lectures beforehand. The assignments, including the articles, were handed out and explained by the tutor at the end of each tutor meeting. Approximately six days later, the students handed in their answers via e-mail. In the following tutor-led meeting, the answers of the students on the assignments were discussed.

The assignments were:

- Assignment 1 (Article 1): Write down verbatim the sentence or sentences that are according to you conclusions and point out which conclusion or conclusions is/are the most important.
- Assignment 2 (Article 2): Write down verbatim the sentence or sentences that are according to you conclusions and point out which conclusion or conclusions is/are the most important. Furthermore, write down verbatim the grounds of each conclusion.
- Assignment 3 (Article 3): Write down the sentence or sentences that are according to you conclusions and point out which conclusion or conclusions is/are the most important. Furthermore, write down the ground(s) of each conclusion. You are allowed to paraphrase the article's sentences.

(To make sure that students knew what we meant, we did not use the word 'ground', but the [language] translation of the word 'support'.)

Comment [EVL20]: Added a comment about the word ground in the assignments.

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10 **Research articles.** The research articles were selected by the course instructors and
11 remained in their original state. All three articles had the conventional Introduction, Method,
12 Results, And Discussion (IMRAD) structure. Article 1 contained approximately 4000 words, one
13 table, and two figures. Article 2 contained approximately 5000 words, six tables, and five
14 figures. Article 3 contained approximately 6000 words, three tables, and six figures. Readability
15 of the articles was measured using the Flesch Reading Ease Score (Flesch, 1948). This score puts
16 texts on a scale between 0 (very difficult to read) and 100 (very easy to read). Article 1 had a
17 Flesch Reading Ease score of 62, Article 2 of 27, and Article 3 of 47. This means that Article 1
18 had a 'standard' readability and that Articles 2 and 3 were, respectively, 'very difficult' and
19 'difficult' to read. Although the readability varied, all research articles satisfied the criteria set
20 out by Muench (2000) for selecting suitable primary literature for novice readers: the
21 experiments in the article could easily be visualised and the given results were unambiguous.
22 Furthermore, the relationship between the conclusion and the data was relatively simple in all
23 three articles. The three articles used subsequently for Assignments 1, 2, and 3 were:

- 34 1) Miranda et al. (2007), in which the authors established if the electrocardiogram (ECG, a
35 recording of the electrical activity of the heart) and/or echocardiogram (ECHO, a moving
36 ultrasound picture of the heart) are able to adequately predict the size of a myocardial
37 infarction in rats.
- 38 2) Kleiger et al. (1987), in which the authors test the hypothesis that the degree of heart rate
39 variability can predict long-term survival after a (acute) myocardial infarction.
- 40 3) Prunier et al. (2007), in which the authors determined if treatment with erythropoietin
41 (EPO) has a positive influence on rats who suffered a myocardial infarction.

42 Furthermore, we performed our own move analysis of the Results and Discussion sections

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10 of the three articles by determining per sentence the type of move (based on the definitions by
11 Dudley-Evans, 1994).

16 Data sources

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18 **Assignments.** All students' written answers were collected. In addition, the two experts
19 made Assignments 1 and 3, and handed them in via e-mail.

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21 **Student interviews.** Four students (Jessica, Bill, Mary, and Leah – fictitious names) were
22 asked to make the assignments during a task-based interview (Goldin, 2000). The task-based
23 interviews took place in a lecture room at the university, where the students had access to an
24 internet-connected computer. Jessica and Bill were observed while making Assignment 1 and 3,
25 Leah was observed while making Assignment 2 and Mary was observed while making
26 Assignment 3. We provided them with paper versions of the research articles.

Comment [EVL21]: Removed the poorly phrased aim of the interviews.

Comment [EVL22]: Added a reference.

Comment [EVL23]: Added a comment about how we provided them with the article.

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28 We asked the students to articulate their thoughts as much as possible while reading the
29 articles and making the assignments. During this process we followed the guidelines of Van
30 Someren (1994). In the semi-structured interview afterwards we asked them general questions
31 about the article and assignment (What did you think of the article? Was it easy to read? What
32 did you think of the assignment? What is a conclusion and how can you recognise it? etc.). In
33 addition, we asked them to tell us how they came to their answers. These sessions were audio-
34 recorded and transcribed verbatim. In addition, students' search history on the computer was
35 registered. We timed how long it took to read the article and make the assignment.

Comment [EVL24]: Replacement of 'if they could motivate their answers'.

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37 **Experts interview.** The interview with the experts took place after the students and experts
38 had handed in the written answers to their assignments. To prepare for the expert interview, we
39 analysed the written answers of students and experts to the assignments. Then we interviewed
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10 the two experts together and asked them to compare each other's written answers and comment
11 on the students' answers. In addition, we asked them some general questions about conclusions
12 and grounds in research articles and their reading strategies. The duration of this interview
13 session was approximately 60 minutes. The session was audio-recorded and transcribed
14 verbatim.
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20 21 22 **Data analysis**

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24 **Assignments.** For the written answers' analysis, we chose the sentence as unit of analysis
25 because, in our experience, sentences (in contrast to paragraphs) seldom contain more than one
26 rhetorical move. For Assignments 1, 2, and 3, we determined how many sentences each student
27 and expert identified as conclusion and in which section of the article (Abstract, Introduction,
28 Method, Results or Discussion) they found them. We made a list of the sentences that were most
29 frequently mentioned as the most important ('main') conclusion by the students. Reporting verbs
30 and transition words/phrases were underlined (Thomas & Hawes, 1994). Then, we compared the
31 student results with the expert results. One student did not hand in Assignment 1. Two students
32 did not hand in Assignment 2.
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41 For assignments 2 and 3, we analysed the grounds students mentioned. We performed two
42 different analyses. In the first analysis we grouped all students' grounds together and determined,
43 based on the definitions by Dudley-Evans (1994), for each conclusion or set of conclusions if the
44 grounds contained an (a) statement of result, (b) finding, (c) citation (i.e. reference to previous
45 research), or (d) another conclusion (i.e. claim). We added one category to this list. Students
46 could also refer to non-textual elements like (e) inscriptions (figures or tables). For this analysis,
47 we used the answers of 17 students; three students did not hand in both assignments. In the
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Comment [EVL25]: Motivated why we added a category.

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10 second analysis we determined if students' grounds for three selected conclusions in each article
11 (assigned by us or the experts as important) were correct (i.e. referred to matching data or data
12 interpretations) and complete (i.e. referred to the most important data or data interpretations
13 mentioned in the text). Correctness and completeness were determined by the experts' comments
14 in the interview and our own analysis. In this analysis, we used data from 14 (Assignment 2) and
15 15 (Assignment 3) students. The other students were left out because they did not mention one of
16 the three conclusions or because of missing data.

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24 **Student and expert interviews.** We marked fragments in the transcripts related to the
25 identification of rhetorical moves (For example: 'This is a conclusion because...'). Then, the
26 two researchers compared and discussed the selected fragments.

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30 The transcripts were used to determine how our subjects identified rhetorical moves. For
31 this purpose, we surmised that rhetorical moves can possibly be identified by content-based,
32 organizational, and lexical features. For example, conclusions can be described as answers to
33 research questions (content-based feature), occur in the Discussion section (organizational
34 feature), and often contain reporting verbs –e.g. suggests, found, show– and transition
35 words/phrases –e.g. overall, so, in summary (lexical features). Grounds consist of experimental
36 results (content-based feature), occur in the Results and Discussion section (organizational
37 feature), and can contain reporting verbs and references to graphs or tables (lexical features).

Comment [EVL26]: Moved this section from the Introduction to the Methods & removed a question.

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45 We also determined what kinds of reading strategies students used by analysing the
46 transcripts and observation notes. Two researchers read the transcripts and observation notes
47 independently and marked fragments which related to reading strategies. For further analysis, we
48 used an adapted subdivision of Brill et al. (2004): (a) connecting prior knowledge (recognising a
49 technical term from a lecture), (b) using illustrations (looking at a graph to understand the

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10 experimental procedures), (c) making predictions (interpreting a graph before reading the
11 interpretation of the author), (d) ignoring technical terms, (e) using the internet (looking up
12 technical terms), (f) repeated reading (rereading certain parts of the article), (g) sequential
13 reading, and (h) selective reading.
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17 18 19 20 **Results**

21 22 **Identification of conclusions by experts and students**

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24 The experts independently identified the conclusions in Articles 1 and 3. The sentences
25 students identified as main conclusion in Articles 1, 2, and 3 are shown in Tables 1, 2, and 3
26 respectively. With asterisks and daggers we show which of these sentences were also mentioned
27 by the experts.
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32 Regarding Article 1, the experts both identified eight sentences in the text. Five of these
33 sentences were the same with both experts (the experts identified in total 11 sentences), so there
34 was considerable agreement between the experts. Both experts agreed that Sentence 1A (Table
35 1) was the most important conclusion. All the sentences identified as conclusions by our own
36 move analysis in Table 1 were also seen as conclusions by one or both experts, except for
37 Sentence 1J (Table 1). It has to be noted that not all experts' conclusions are included in Tables 1
38 and 3, because the tables only contain sentences mentioned by students as main conclusion.
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Comment [EVL27]: Added a comment which explains why table 1 does not include all the experts' conclusions.

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46 Regarding Article 3, Expert A phrased as main conclusion (because he paraphrased his
47 answer, we could not link his conclusions with one of the sentences in the tables): 'Of the 2
48 doses of darbepoetin (0.75 and 1.5 µg/kg, injected once a week for 8 weeks) only the highest
49 dose improves cardiac function and architecture in a rat model of myocardial infarction. The
50 mechanism is unknown.' In addition, he phrased three minor conclusions:
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Comment [EVL28]: Added a comment which explains why his conclusions are not visible in table 3.

- ‘The hematocrit was dose dependent increased by both doses of darbepoetin’
- ‘Only the highest dose increases the number of circulating EPC’s’
- ‘Only the highest dose increases the capillary density’

Expert B identified sentence 3E (Table 3) from the Abstract as a main conclusion.

Comment [EVL29]: Added a reference to Table 3.

Furthermore, he identified three conclusions in the Discussion (which together form the integrated conclusion): sentences 3A, 3B, and 3C (Table 3). The sentences identified as conclusions by Expert B were also conclusions according to our own move analysis. In contrast, the sentences of Expert A are probably more close to findings than to conclusions.

[Insert Tables 1, 2, 3, and Figure 1 about here]

Students predominantly identified sentences from the Discussion section as conclusions. In total, students identified 36, 35, and 24 sentences as conclusions in Articles 1, 2, and 3, but only the sentences mentioned as main conclusions are shown in the tables. Not all identified sentences are actual conclusions; students also identified findings and statements of result as conclusions. This was especially the case for Article 2. The average number of sentences identified as conclusions was 10.9 (Article 1), 7.1 (Article 2), and 6.2 (Article 3). So, as the course progressed, students identified on average less sentences as conclusions (Figure 1). With 16 of the 20 students we saw a reduction in the number of sentences identified as conclusion (comparing Assignment 1 with Assignment 3) – even though Article 3 has approximately 2000 more words than Article 1.

In Tables 1, 2, and 3 we underlined the reporting verbs and transition words/phrases which could signal a conclusion. It is interesting to observe that Table 2, in stark contrast to Tables 1

Comment [EVL30]: ‘marked’ replaced by ‘underlined’

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10 and 3, contains only two sentences with a reporting verb or transition phrase.
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14 We observed that students identified on average more conclusions than the experts did. The
15 students identified on average 10.9 sentences in Article 1 (with very varied scores – four students
16 identified five or less sentences, five students identified six to nine sentences and 10 students
17 identified 10 sentences or more), while the experts identified only eight each. The same
18 difference, although less pronounced, was seen in Article 3. Nevertheless, as the course
19 progressed, students identified on average less sentences as (main) conclusions. It is interesting
20 to observe that the sentences the students identified in Articles 1 and 3 almost always contained a
21 reporting verb or transition phrase. This in contrast to the sentences identified in Article 2. It also
22 seems that there was (compared with Articles 1 and 3) less consensus between the students about
23 the main conclusion of Article 2: there was not a single sentence which was identified as main
24 conclusion by a majority of the students. However, there was considerable agreement between
25 students and experts regarding the main conclusion of Articles 1 and 3. With the exception of
26 Article 3, students identified a wide range of sentences which were not seen as conclusions by
27 the experts or by our own move analysis. Instead, the students identified a great number of
28 findings and statements of results as conclusions. Furthermore, it should be noted that not all
29 conclusions found by our move analysis were recognised as such by our experts.
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45 Regarding Article 3, it is interesting to observe that 10 of the 20 students combined two
46 conclusions: the one which described the effects of the treatment (attenuation of cardiac
47 modelling and an improvement of cardiac function) and the one which described a possible
48 mechanism (EPC mobilisation and increasing capillary density) for these effects. In contrast, the
49 experts did not cluster these conclusions: they made a clear distinction between these two.
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Features used by experts and students for identifying conclusions

We asked the experts how they identified conclusions. As Expert A stated in the interview, a conclusion is the answer to the research question. 'And one has data to justify it. But data are only data. They only have meaning in a context. And that is the conclusion. (...) in the research question you have the context taken into account and you have tried to manipulate it so that you can use the data to reach a certain conclusion.' According to Expert B, the conclusion is the summarised answer to the questions of the authors, justified with data.

Expert A stated that a conclusion should really stay close to the data. Additionally, there are conclusions which are placing the research into perspective ('like... what does this mean for humankind, for the climate problem, for the expansion of the universe'). Expert B made another distinction: there is a main conclusion (which is rather broad) and there are minor conclusions (or sub-conclusions) which are pointing to the main conclusion.

Expert A added to this remark that there are two types of sub-conclusions. There are sub-conclusions which 'specify the broad, big thing' and there are sub-conclusions which consists of information that can be useful to other researchers. For example, 'method A is superior to method B, C and D because of...'

When they determined the importance of conclusions, the experts used three criteria: (1) does it answer the research question, (2) how 'big' is the conclusion, and (3) how much evidence is given? Furthermore, the experts used domain knowledge while they determined the importance of conclusions. Take, for example, the following conclusion which was identified by Expert A: 'It is interesting to observe that these values were already modified within 24 hours of the infarction and the ECHO was sensitive enough to detect these alterations precociously.'

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10 According to him this was a reasonably important conclusion, because the researchers
11 ‘themselves, I think, had never expected that the first time point was suitable.’

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13 When the experts examined the students’ answers (Table 1), they noted that some of the
14 students’ sentences were not conclusions but results. An example is Sentence 1B (Table 1). As
15 Expert A said: ‘This is in my view not a conclusion, because it is a description of the data. (...)
16 This is a nice sentence which describes relations between data, but it does not give an
17 interpretation.’ Expert B added: ‘It describes something and it is maybe important data (...) on
18 the basis of this you (...) have to make a conclusion.’

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20 The students also identified Sentence 1J (Table 1) as conclusion. According to Expert A,
21 this was not a conclusion because the sentence contained no new information. ‘This is intrinsic to
22 the model: you always see this. (...) This is known for years.’

23
24 We also asked the four interviewed students how they identified conclusions. According to
25 Bill and Jessica, a conclusion is the answer to the research question. Bill remarked that the
26 research question and the conclusion are sometimes formulated in the same way: ‘The question
27 was: can an ECG do this. And if you read: this ECG can do or can’t do this... then... so it is
28 formulated a little bit the same as the question. Then... I think: hey, that’s a conclusion.’ Bill,
29 like Mary, also used textual markers (like ‘we conclude...’) to identify conclusions.
30 Nevertheless, Mary found it difficult to distinguish conclusions from other statements.

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32 Interestingly, Jessica also said that a conclusion could be a sort of summary. She stated:
33 ‘Here they really state the conclusion. At this point they summarise it shortly.’ Leah also thought
34 that conclusions could be a summary: ‘They summarise a little bit the previous text and they tell
35 what you can do with it (...) and it is an important advance [in the research field] (...) so it seems

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10 a conclusion to me.’ Later on, Leah stated that a conclusion could also be an explanation: ‘...and
11 then they explain why, so I think this is also a conclusion.’

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13 How did the students decide how important each conclusion was? Jessica reasoned that the
14 most important conclusion is the one that answers the most important research question. And,
15 according to Jessica, the most important research question is the one that is mentioned first by
16 the authors. As Jessica put it, when asked why a certain conclusion was the most important one:
17 ‘Because... that one... that one is the answer to the first research question (...) that is the first
18 thing they want to know.’ Leah used another method. According to her, the most important
19 conclusions were the ones that summarise the research and tell what you can do with it. The
20 conclusions which were ‘directly deduced from the results’ were less important.
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32 We observed a number of differences between experts and students on the identification of
33 conclusions. The experts used rather specific content knowledge when they identified
34 conclusions and rated their importance. For example, they saw a certain sentence not as
35 conclusion, because the information was not new. Students used also lexical features (like
36 reporting verbs) and organizational features (like the place of the sentence in the paragraph) –
37 even though they understood the articles rather well (according to themselves). Furthermore, the
38 students formulated two different definitions of a conclusion: it answers the research question
39 and it summarises the results. The experts defined the conclusion only as an answer to the
40 research question(s).

Comment [EVL31]: Removed
‘It seems students used these
definitions as rules of thumb’
before this sentence.

51 **Identification of grounds by experts and students**

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53 Experts’ written answers regarding the identification of grounds (see the section Genre
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10 Analysis of this paper for a definition of grounds) were rather different from students' answers.

Comment [EVL32]: Added a reference to the definition.

11 For example, the conclusions for which expert A gave grounds, were phrased by himself. This
12 made student-expert comparisons difficult. So, for the analysis of the students' answers we used
13 experts' comments in the interview and our own content knowledge. We observed that the
14 experts preferred to use data sources as grounds (e.g. 'CD31 data'). Both experts did not mention
15 citations as grounds.
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21 We analysed written assignments 2 and 3 to elucidate which kinds of grounds students
22 identified. We grouped 17 students' grounds and determined how many times an inscription,
23 statement of result, finding, citation, and another conclusion was mentioned (Table 4). In total,
24 the 17 students gave grounds for 109 (Assignment 2) and 74 (Assignment 3) text fragments.
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27 These fragments were not necessarily unique and often contained multiple sentences; students
28 tended to give grounds for aggregations of conclusions. Students most often mentioned
29 inscriptions as grounds. Citations were also frequently mentioned. Conclusions were least
30 frequently mentioned as grounds (Table 4).
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Comment [EVL33]: Clarified this sentence.

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34 We also analysed the completeness and correctness of grounds for Assignments 2 (Table 5)
35 and 3 (Table 6). To this end, we classified the grounds on the basis of the data sources used in
36 the articles (and not according to Dudley-Evans, 1994). This analysis was done for a selection of
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Comment [EVL34]: Shortened this bit and removed an incorrect description of the data.

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The same goes for Table 6: of all the 36 grounds, only eight were incorrect.

Comment [EVL35]: Added a remark about the classification in tables 5 and 6.

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12 [Insert Tables 4, 5, and 6 about here]
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15 16 **Features used by experts and students for identifying grounds**

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18 What features do experts use to identify grounds in an article? Experts saw the grounds (or
19 evidence, as they call it) as among the most important aspects of an article. As Expert A said:
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21 ‘The body of evidence in an article is very important and you continually look back at it. In fact,
22 I’m interested in the conclusions of the authors, but more to direct my own thinking process.’
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24 According to Expert A, it is necessary to form your own conclusions, because the conclusions of
25 authors are not always uncontested. However, the most important evidence can be found in the
26 Discussion section. As Expert A said about writing the Discussion: ‘If you just say: well, this
27 does it... look, go to the data... then it will be a little bit a puzzle. So usually, I try to mention the
28 two or three most important grounds before [the conclusion].’
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36 When asked what they expected from students regarding the identification of grounds, they
37 stated that they want students to mention at least one reference to the results per conclusion.
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39 They rather see that students refer to original data than to cited research. Citations are, according
40 to the experts, weak evidence. Expert B: ‘You have to show it yourself.’
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46 We also interviewed our four students about the identification of grounds. When Leah tried
47 to find the grounds of the conclusions of Article 2, she admitted that she found it rather difficult:
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49 ‘Sometimes I didn’t have a clue where [the authors] got it from.’ She often looked for textual
50 clues (rather than via inferring) when deciding which ground belonged to a certain conclusion.
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53 Take, for example, Sentence 2H (Table 2). According to Leah, this sentence was justified by a

Comment [EVL36]: Replaced
“conclusion” with “sentence”.

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10 table in which RR-intervals are given. When asked why, she remarked: 'Because it's about the
11 RR-interval.' Leah distinguished three types of grounds: results, citations, and other conclusions.
12 Results are the most important grounds, according to Leah: 'Because they just measured it, so
13 you know for sure that it is true.' The second most important grounds are other conclusions. The
14 least important grounds are citations, because 'literature can be obsolete or superseded'.
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19 Jessica was better able to explain the relationship between her grounds and conclusions of
20 Article 3. She looked more at the content of the conclusion, before deciding which grounds were
21 related to it. She made a distinction between the main conclusion (which was justified by 'all the
22 results') and other conclusions (which were justified by authors' results or citations).
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27 Mary had a similar approach: she looked at each figure and table and then decided which
28 conclusion related to it. For example: 'Let's see. Figure 5 (...) I think the black bar indicates that
29 it's higher... that there are more EPC's mobilised and that's what the conclusion also says.'
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35 In summary, it seems that students like to stay as close to the original data as possible when
36 they have to give grounds for conclusions. A table or graph is more likely seen as ground than an
37 interpretation of said inscription (e.g. statement of result, finding or conclusion). On the whole,
38 the grounds given by students were correct. The grounds they mentioned mostly matched with
39 their conclusions. However, students sometimes failed to mention important grounds for a
40 particular conclusion. Students seemed to prefer the use of inscriptions as grounds, but also
41 referred to statements of results and findings. This in contrast to experts, who did prefer to
42 mention only a general description of the data source (e.g. 'CD31 data'). Another difference
43 between experts and students was the use of citations as grounds. Experts did not attach much
44 importance to citations and did not mention these as grounds, while students occasionally
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Comment [EVL37]: Replaced 'frequently' with 'occasionally'.

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10 referred to citations. (Although it has to be noted that students not often used citations for the
11 sentences mentioned in Tables 5 and 6 – probably because these sentences were major
12 conclusions for which the authors provided mainly grounds derived from the experimental
13 results instead of references to previous research.)

Comment [EVL38]: Explained an anomaly in the data.

14 15 16 17 18 19 20 **Reading strategies used by students**

Comment [EVL39]: Moved this section from the beginning of the Results to the end.

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22 To give an impression how students deal with the task of reading a research article, we now
23 present the reading strategies of four students: Bill, Jessica, Leah, and Mary.

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25 **Bill.** When reading the article for the first time, Bill used a sequential reading style. He
26 seldom jumped back and forth. However, he adopted a more non-sequential reading style when
27 making the assignment. Bill skimmed his articles, so he read rather quick. He spent 1 hour and
28 10 minutes on Assignment 1 and 1 hour and 30 minutes on Assignment 3 (including reading the
29 article). Bill skipped some parts of the article (for example the paragraph about the statistical
30 analysis, because ‘for this assignment it is not important’). Bill also found the Discussion much
31 more important than the Results section. ‘I understood the conclusions, and that is (...) what is
32 really important for an article. (...) How they came to it... that is more... more a proof like: it is
33 really the case.’

34
35 Bill did not pay much attention to inscriptions. Instead he looked for verbal descriptions of
36 tables and figures. As Bill said: ‘Here they say in words what was presented in the table. That’s
37 easy.’ Bill skipped sentences in which previous research was referenced. As he said: ‘If you
38 read: those and those have studied this, that’s not interesting.’

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40 Bill tended to ignore unknown technical terms. Bill thought it would be much effort for
41 little gain to look them up: ‘Now they describe their methods. That’s not very interesting.’

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10 Because... things like the Simpson's method... Well, I have to look up who Simpson is. And this
11 is probably more work than it is worth.' However, he looked up one technical term on the
12 internet during Assignment 1, and two technical terms during Assignment 3.

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15 **Jessica.** Jessica read her texts mainly sequentially during the first reading and seldom
16 jumped back and forth. Later on, while making the assignment, she adopted a more non-
17 sequential reading style. She spent 1 hr 45 min on Assignment 1 and 2 hr 10 min on Assignment
18 3.
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24 While reading, Jessica tried to develop her own explanations and predictions. 'Well, so
25 apparently it is different when they look at the dead rat... when they look what the... yes... what
26 the condition is of the heart. But I think what happens next is that it will get worse or something
27 like that. That you first have an infarct and that after a certain amount of time... that they see that
28 the situation will get even more worse.' While reading the results, Jessica tried to interpret the
29 findings of the authors. For example: 'There is a reduction in the amplitude (...) so the situation
30 gets worse.' Or: 'Well, it looks like their hypothesis is correct.' Jessica admitted that she reads
31 the Results section quite intensively. 'Yes... actually... I spend maybe too much time on it. But I
32 find it interesting to read.'

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Jessica did not pay much attention to the article's inscriptions. 'Everything is in the text. I
only look at graphs and tables if I'm confused about something.' After reading the Discussion of
Article 1, Jessica said that reading the results had made understanding the Discussion easier. 'It's
really valuable to read the results. It makes things clearer. Because... yes, otherwise... I don't
think I could have understand quite as good what they were saying.'

Jessica seemed to be the only one of the four students who actively compared results from
referenced research with the authors' results. Jessica did not frequently look up words on the

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10 internet: 'First I try to read further as much as possible to see if I can make out [the meaning of a
11 term]. If I can't I will look them up on the computer.' She looked up 2 technical terms during
12 Assignment 1. During Assignment 3 she did not look up technical terms.

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15 **Leah.** Just like Jessica and Bill, Leah read sequentially during her first reading. When
16 making the assignment, she began to jump back and forth. Leah skimmed the article and spent 2
17 hr 5 min on Assignment 2. She read the whole article (minus the Abstract), but did not 'take up'
18 everything, especially the method and the Results section. Instead, she tried to distil the big
19 picture. Leah did not pay much attention to the inscriptions. Leah ignored sentences in which
20 previous research was mentioned, because 'you don't need it.' She remarked: 'It is only a small
21 report of old studies.' She also ignored technical terms and did not look them up on the internet.

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30 **Mary.** Mary was the only student who read non-sequentially right from the start. She
31 began with reading the Abstract ('to look what kind of research they actually do and what they
32 want to achieve with it') and then read the Discussion section. She reasoned that reading the
33 Discussion section was the best way to start when you have to identify the conclusions. Then she
34 read the Method section. In hindsight, she did not think that her reading strategy was sensible,
35 because in the beginning she had great difficulty with understanding the content of the article. 'If
36 I had read it calmly from the beginning... then I would have understand it better at once.'

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Mary tried to interpret the data presented in the article. Although she did not read the text
of the Results section, she did study the figures and tables quite thoroughly. 'First I try to
interpret the figures a little bit (...) and if this fails you read the text, of course. I always read the
caption (...) much will be clear on the basis of graphs.' She did this because she found the text in
the Results section which described the data 'very abstract'. She spent 1 hr 45 min on
Assignment 3. She looked up five technical terms on the internet.

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12 In general, our students read selectively and sequentially. Furthermore, Bill and Leah used
13 rather pragmatic reading strategies. In contrast, the reading strategies of Jessica and Mary were
14 more active; e.g. they made predictions. All students said they understood the articles. However,
15 we observed some comprehension difficulties, especially regarding the technical terms in the
16 Method section. The students dealt in different ways with these difficulties. Bill and Leah tended
17 to ignore unknown technical terms, while Jessica and Mary tried to find out their meaning on the
18 internet. Overall, we encountered similar strategies as Brill et al. (2004).
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28 Discussion

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30 Regarding the identification of conclusions, our results suggest that students, in contrast to
31 experts, rely heavily on organizational and lexical features while reading a research paper. The
32 students were able to find the most important conclusion (according to the experts), although the
33 other sentences they identified as conclusions were quite different from the experts. Students
34 referred to sentences that were according to the experts definitely not conclusions. Experts were
35 using more content-based features for the identification of conclusions. This is probably the
36 reason why some of the sentences we identified as conclusions in our own move analysis (based
37 on Dudley-Evans, 1994) were not identified as such by the experts. For example, Sentence 1J
38 (Table 1) was not seen as conclusion by the experts because it contained no new information.
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48 These findings correspond with Dee-Lucas and Larkin (1988), who discovered that novice
49 and expert readers used different rules for judging the importance of certain text elements.
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51 Novice readers tend to judge the importance of sentences by their form, while expert readers
52 judge the importance of sentences by their content. For example, 'novices consider the same
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Comment [EVL40]: Removed a remark about students using certain rules of thumb.

Comment [EVL41]: Removed 'nevertheless' at the beginning of this sentence.

Comment [EVL42]: Added: '(according to the experts)'

Comment [EVL43]: Added a reference to Dudley-Evans.

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10 substantive information to be more important when presented as a definition (rather than a fact)
11 and as an equation (rather than a verbal phrase)' (Dee-Lucas and Larkin, 1988, p. 306). This so-
12 called 'form effect' was not seen in the group of experts.
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15 When students identify grounds, we see the reverse: the grounds are correct (i.e. referred to
16 matching data or data interpretations), but students do not always mention the most important
17
18 ones. Sandoval and Millwood (2005) described similar problems when high school students gave
19 written explanations for two problems of natural selection – using existing data sets that students
20 could explore with a special computer software. They saw that students had difficulty with citing
21 sufficient evidence for claims and linking specific inscriptions (figures or tables) to particular
22 claims. Kelly, Regev, and Prothero (2008) described some criteria for determining the quality of
23 (written) scientific argumentation. One of these criteria is the coordination of evidence across
24 epistemic levels in articles: the explicitation of 'how particular inscriptions or claims provide
25 evidence for higher order, more generalized claims' (p. 133). Our results imply that
26 understanding this coordination of evidence is quite challenging for students when reading a
27 research article.
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Comment [EVL44]: Explained what we mean with 'correct'.

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31 We found that the interviewed undergraduate students read their articles selectively. They
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33 skipped or skimmed for example the Method section, because they thought it was not relevant
34 for the assignment. Our students (with one exception) read their articles sequentially. Experts,
35 who have disparate purpose laden schema, read differently: they read selectively, just like
36 students, but unlike students they read non-sequentially (Bazerman, 1988).
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Comment [EVL45]: Replaced 'investigated if the' by 'found that the interviewed'.

Comment [EVL46]: Removed: 'This was the case for our interviewed students.'

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41 The choice of articles could have influenced our results. For instance, it is possible that the
42 textual organization could have affected students' answers. The main conclusion of Articles 1
43 and 2, for example, was placed at the beginning of the Discussion, while the main conclusion of
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10 Article 3 was placed at the end. However, in both cases students seem to be able to find the main
11 conclusion. Other **textual features** could also have influence. Article 2, a correlation study,
12 contains a vague research goal ('...to gain insight into the relations of these variables and HR
13 variability to mortality') compared to Articles 1 and 3. **This could explain why there was less**
14 consensus in students' answers to Assignment 2.
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Comment [EVL47]: Replaced
'factors' with 'textual features'.

Comment [EVL48]: Removed:
'Articles 1 and 3 are empirical
studies with very clear-cut research
goals.'

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20 The interviewed students seemed to have no major problems with understanding the
21 concepts used in the articles (apart from some technical terms, see also Brill et al., 2004). This is
22 probably due to the lectures students attended before reading the articles, in which relevant
23 concepts were presented. This ensured that students had sufficient prior knowledge. It is
24 generally accepted that prior knowledge plays a substantial role in text comprehension. Ozuru
25 (2009) suggests that readers' level of prior knowledge is even more important than their general
26 reading skills for comprehending expository science texts.
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34 Our students were non-native speakers of English. We surmise that this factor did not have
35 a significant impact on text comprehension. On the whole, [nationality] students are well-versed
36 in English language. All textbooks students use are in English, so they have ample experience in
37 reading English science texts. Furthermore, research suggests that students' language skills play
38 a much less important role than conceptual knowledge with respect to the comprehension of
39 scientific texts (Chen & Donin, 1997).
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46 It would be worthwhile if we could advance students' skills to a higher level of competency
47 in such a way that they gradually use more expert-like strategies while reading and
48 understanding a research article. To achieve this aim, we want to combine ideas from genre
49 analysis and cognitive apprenticeship into a teaching strategy. By reading research articles
50 students gain generic practice: '...the ability to respond to recurrent and novel rhetorical
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10 situations by constructing, interpreting, using and often exploiting generic conventions
11 embedded in specific disciplinary cultures and practices to achieve professional ends' (Bhatia,
12 2004, p. 144). In this way, students are slowly becoming part of a community of practice.
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15 Integration into a community of practice is described by Lave and Wenger (1991) as 'legitimate
16 peripheral participation'. The scientific community in which our students were absorbed by
17 legitimate peripheral participation can be described as a summation of many different activity
18 systems. An activity system can be defined as 'any ongoing, object-directed, historically-
19 conditioned, dialectically-structured, tool-mediated human interaction (...) These activity
20 systems are mutually (re)constructed by participants using certain tools and not others (including
21 discursive tools such as speech sounds and inscriptions)' (Russell, 1997, p. 510).

Comment [EVL49]:

Removed: 'Ultimately, this process will lead to full participation in a community of practice.'

We can distinguish some notable differences between the activity systems of students and experts regarding reading research articles. 1) Due to their experience in reading and writing

Comment [EVL50]: Removed: 'An activity system consists of a subject, object, tools, rules, community, and division of labor (Engeström, 1987).'

Comment [EVL51]: Removed: 'Students and experts function in different activity systems'.

research articles, experts have a better grasp of the rhetorical moves used in research articles. Experts know how conclusions are interwoven in the Discussion section of an article. They know which semantic structures authors use to connect grounds with conclusions. They have, in other words, 'rhetorical consciousness'. Students do not possess this kind of knowledge. 2) Experts have a better understanding of the conceptual/epistemological nature of argumentative elements like the conclusion and grounds. Experts know better which conclusions and which grounds are valid or not. 3) Experts have more prior knowledge than students. Experts usually are familiar with the technical terms mentioned in research articles and understand immediately why and how certain experiments have been done and how to interpret the presented data. Furthermore, they have access to tools (like handbooks) which can help them understanding the article. This makes it easier for experts to follow the lines of reasoning in an article. 4) Experts read with a

Comment [EVL52]: 'between students and experts' replaced by 'between the activity systems of students and experts regarding reading research articles'

different goal than students, because they function in a different community. Students' reading is assignment driven, while experts read because they want to incorporate the information into their research.

In conclusion, our study demonstrates that our students are to a certain degree able to read and understand research articles. Our results show that students and experts defined conclusions and grounds in different ways. Students and experts agreed on the most important conclusion of the articles. However, students identified a wide range of sentences which were not seen as conclusions by the experts. The grounds students mentioned mostly matched with their conclusions. However, in some cases students failed to mention important grounds for a particular conclusion.

Comment [EVL53]: Added the main conclusions from our research..

In our future teaching strategy, we want to focus on the abovementioned first and second student-expert differences. The other differences are more difficult to bridge. It is impossible to bring the knowledge of students on a par with experts in the short period of a course and the goals of students and experts are often quite different while reading a research article. So, in our future teaching strategy we will direct our attention to the textual structure of scientific text and the conceptual/epistemological nature of rhetorical elements. Students should be given clear, transferable criteria for identifying these elements. Future research will elucidate if this teaching strategy will improve students' reading skills.

Comment [EVL54]: Removed: 'undergraduate students are not always doing research, so reading articles will often be assignment driven – although in recent years some educators have emphasised the importance of research-based teaching in higher education (Griffiths, 2004).'

Comment [EVL55]: Changed the order of sentences.

Comment [EVL56]: Removed: 'They are, for example, sometimes confused about what a conclusion entails. These criteria must be conceptual/epistemological and structural, so that students are encouraged to focus on content and form.'

Comment [EVL57]: Added a new closing sentence.

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Comment [EVL58]: Added a reference.

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Comment [EVL59]: Added a reference.

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Comment [EVL60]: Corrected a reference.

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49 Our sincere gratitude to [name], [name], and the students and tutors of the course ‘Biomedical
50 Research’.
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Table 1

Sentences identified as main conclusion by students (n=19) in Article 1.

I	II	III	IV	V	VI
1A	D	<u>In summary</u> our data <u>show</u> that ECG and ECHO detect non-invasively MI in rats and that these methods can be used to estimate infarct size. ^{*†}	17	16	Conclusion
1B	D	The most significant correlations <u>were found</u> between echocardiographic parameters and infarct size as measured by histopathology; among these, LV diastolic and systolic volumes 7 days after MI, and M-mode SF% and EF% at 7 and 28 days post-MI.	10	8	Finding
1C	D	Our data further <u>suggest</u> that the 7 day interval is actually the most accurate for estimation of infarct size by echocardiography. ^{*†}	8	5	Conclusion
1D	D	These data <u>suggest</u> that the best time point to estimate infarct size by M-mode CHO is at 7 days post-surgery. ^{*†}	17	3	Conclusion
1E	A	<u>In summary</u> we <u>show</u> that conventional ECG and ECHO methods can be used to estimate infarct size in rats. [†]	3	3	Conclusion
1F	D	<u>Overall</u> , the conventional ECG is an excellent marker for MI but a poor predictor of infarct size. ^{*†}	15	2	Conclusion
1G	D	By ECHO we <u>found</u> a correlation between infarct size and LV dilatation only at 7 days post MI.	9	2	Finding
1H	D	A negative correlation between infarct size and ejection fraction and shortening fraction by M-mode <u>was found</u> at 7 and 28 days post MI (Figs. 2-C and 2-D).	9	2	Statement of result
1I	D	<u>Thus</u> , in the examinations at 28 days post-infarct, a positive correlation between E/A ratio and infarct size was found, suggesting that animals with a larger infarct have greater diastolic dysfunction. [*]	13	1	Finding/Conclusion
1J	D	These findings <u>imply</u> that besides systolic dysfunction, the infarcted group also has important diastolic dysfunction.	13	1	Conclusion
1K	R	This <u>implies</u> that M-mode echocardiography can be used as an estimate of infarct size in this time interval. [†]	6	1	Conclusion
1L	D	The echocardiogram is a useful tool in the evaluation of cardiac function and alterations in the morphology of the heart in a noninvasive form.	6	1	Information move
1M	R	Importantly, on day 7 post-infarction, there was a negative correlation between infarct size, ejection and shortening fraction determined by M-mode as shown in Figures 2-C, 2-D.	3	1	Statement of result
1N	R	Negative correlation <u>was also found</u> between infarct size, ejection and shortening fraction on day 28 post-surgery (R = -0.63, p < 0.05, N = 11; R = -0.65, p < 0.05, N = 11; respectively) and [t]here is correlation between E/A ratio and infarct size at 28 days post infarction (R = 0.71, N = 10, p = 0.02).	3	1	Statement of result
1O	R	Our data <u>suggest</u> that the 7-day interval is actually the most accurate for estimation of infarct size by ECHO. [†]	2	1	Conclusion

Note. Column II: Location of the sentence (A=Abstract, R=Results, D=Discussion). Column III: Sentence identified as main conclusion. Column IV: Number of students who mentioned this sentence as conclusion. Column V: Number of students who mentioned this sentence as main conclusion. Column VI: Rhetorical move of the sentence according to authors, following Dudley-Evans (1994). Reporting verbs and transition words/phrases are underlined.

*Sentences identified as conclusion by Expert A. †Sentences identified as conclusion by Expert B.

Comment [EVL1]: Changed numbering of columns. (done the same for Tables 2 and 3)

Comment [EVL2]: Added a remark about who determined the moves. (done the same for Tables 2 and 3)

Comment [EVL3]: Added a remark about the underlined words. (done the same for Tables 2 and 3)

Table 2

Sentences identified as main conclusion by students (n=18) in Article 2.

I	II	III	IV	V	VI
2A	R	Decreased HR variability increases the risk of death irrespective of average HR (Fig. 2), variables reflecting left ventricular function (Fig. 3), those measuring ventricular ectopic activity (Fig. 4 and 5), clinical or demographic variables (Table V) or drug treatment (Table VI).	12	7	Statement of result
2B	D	The present study <u>suggests</u> that patients with decreased HR variability have decreased vagal tone or increased sympathetic tone and may have higher risk of ventricular fibrillation.	15	5	Conclusion
2C	D	Furthermore, HR variability has a significant and strong association with mortality during follow-up even after adjusting statistically for ventricular arrhythmias detected in the <u>same</u> Holter recording.	13	5	Finding
2D	D	<u>Thus</u> , the strong univariate association with mortality (the strongest of any Holter variable) along with the ease and low cost of measuring HR variability make it an important advance in postinfarction risk stratification.	12	4	Conclusion
2E	D	Using HR variability together with information about ventricular arrhythmias will improve substantially the prediction of outcome.	9	3	Conclusion
2F	D	These speculations have therapeutic implications: agents that blunt sympathetic influence or agents that promote vagal influence may have therapeutic value after infarction, particularly in patients with low HR variability.	4	2	Conclusion
2G	A	HR variability remained a significant predictor of mortality after adjusting for clinical, demographic, other Holter features and ejection fraction.	2	2	Finding
2H	D	In the present study, HR variability computed from all of the RR intervals in a 24-hour continuous electrocardiographic recording made 11 ± 3 days after infarction was significantly and strongly associated with subsequent mortality.	9	1	Finding/Conclusion
2I	D	Beta-blocking drugs reduce the risk of mortality after myocardial infarction, in part because of their antiarrhythmic and antifibrillatory actions. ^{33,34}	2	1	Citation
2J	A	HR variability is a predictor of long-term survival after acute myocardial infarction.	1	1	Conclusion
2K	A	Of all Holter variables measured, HR variability had the strongest univariate correlation with mortality.	1	1	Finding
2L	R	The association of HR variability with survival is statistically significant when evaluated with the proportional hazards model, using HR variability as measured	1	1	Finding
2M	D	HRV computed from all of the RR intervals in a 24-hour continuous electrocardiographic recording made 11 +/- 3 days after infarction was significantly and strongly associated with subsequent mortality.	1	1	Finding

Note. Column II: Location of the sentence (A=Abstract, R=Results, D=Discussion).
 Column III: Sentence identified as main conclusion. Column IV: Number of students who mentioned this sentence as conclusion. Column V: Number of students who mentioned this sentence as main conclusion. Column VI: Rhetorical move of the sentence according to authors, following Dudley-Evans (1994). Reporting verbs and transition words/phrases are underlined.

Table 3

Sentences identified as main conclusion by students (n=20) in Article 3.

I	II	III	IV	V	VI
3A	D	These results <u>show</u> that chronic EPO treatment beginning 7 days after MI reperfusion in rats attenuates cardiac remodeling and improves cardiac function. [†]	18	15	Conclusion
3B	D	These effects occurred only with an EPO dose that induced EPC mobilization in blood and increased capillary density in the MI border zone. [†]	12	8	Conclusion
3C	D	The improvement in cardiac contractility was clearly related to EPC mobilization. [†]	8	4	Conclusion
3D	D	To our knowledge, this is the first study <u>suggesting</u> beneficial effects of chronic EPO therapy at standard doses after I/R.	4	2	Conclusion
3E	A	We <u>found</u> that chronic EPO treatment reduces MI size and improves cardiac function only at a dose that induces EPC mobilization in blood and that increases capillary density in the infarct border zone.	2	2	Conclusion
3F	R	No significant difference <u>was observed</u> between untreated MI rats and infarcted rats receiving the lower dose of EPO.	1	1	Finding
3G	R	In contrast, the higher dose of EPO prevented anterior wall thinning and LV dilatation and preserved LV systolic function (Table 1).	1	1	Statement of result

Note. Column II: Location of the sentence (A=Abstract, R=Results, D=Discussion). Column III: Sentence identified as main conclusion. Column IV: Number of students who mentioned this sentence as conclusion. Column V: Number of students who mentioned this sentence as main conclusion. Column VI: Rhetorical move of the sentence according to authors, following Dudley-Evans (1994). Reporting verbs and transition words/phrases are underlined.

[†]Sentences identified as conclusion by Expert B.

Table 4

Kinds of grounds identified by students (n=17).

	Assignment 2	Assignment 3
Inscription	49%	39%
Statement of result	18%	27%
Finding	15%	12%
Conclusion	5%	9%
Citation	23%	26%

Note. In total, the students gave grounds for 109 (Assignment 2) and 74 (Assignment 3) text fragments. The percentages denote in how many instances students mentioned an inscription, statement of result, and so forth, as ground for their text fragments.

Comment [EVL4]: Added a comment about the total number of grounds.

Table 5

The grounds of three selected conclusions in Article 2 as given by 14 students.

Sentences identified as conclusion	Number of students	Grounds							Citation
		Other conclusion	Mortality	Correlation with other variables	Univariate/independent relations	Effects of drugs	HRV & runs/couplets		
2H	8	0	5	1	2	1	0	3	
2D	10	2	1	1	7	0	0	1	
2E	7	1	0	0	1	0	5	1	

Note. Sentences can be found in Table 2. A grey cell indicates that the ground is incorrect according to the experts.

Table 6

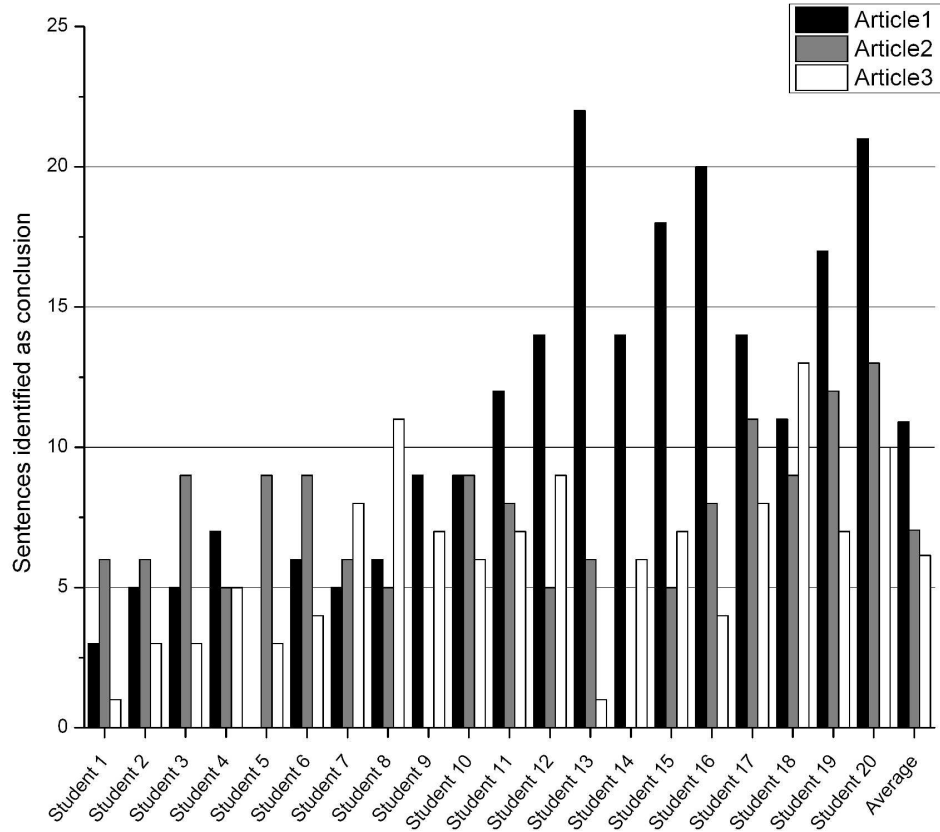
The grounds of three selected conclusions in Article 3 as given by 15 students.

Comment [EVL5]: Changed Article 2 into Article 3.

Sentences identified as conclusion	Number of students	Grounds							
		Other conclusion	Heart function	Infarct size	Cappillary density	CD31	Hematocrite	Apoptosis	Citation
3A	8	2	2	3	2	1	1	0	1
3B	2	0	1	1	2	0	0	0	0
3C	2	0	0	0	1	1	0	0	0
3A+3B	3	1	2	0	1	2	0	1	1
3A+3B+3C	4	1	2	2	2	2	0	0	1

Note. Sentences can be found in Table 3. A grey cell indicates that the ground is incorrect according to the experts.

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