

Baseline assessment in writing research: A case study of popularization discourse in first-year undergraduate students

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Abstract: In popularization discourse, insights from academic discourse are recontextualized and reformulated into newsworthy, understandable knowledge for a lay audience. Training in popularization discourse is a relatively new and unexplored research topic. Existing studies in the science communication field suffer from under-utilized baseline assessments and pretests in teaching interventions. This methodological problem leads both to a lack of evidence for claims about student progress and to a gap in knowledge about baseline popularization skills. We draw the topic into the realm of writing research by conducting a baseline assessment of pre-training popularization skills in first-year undergraduate students. Undergraduate science communication texts are analyzed to identify instances of popularization strategies using a coding scheme for text analysis of popularization discourse. The results indicate a lack of genre knowledge in both academic and popularized discourse: textual styles are either too academic or overly popularized; the academic text is misrepresented; and the essential journalistic structure lacking. An educational program in popularization discourse should therefore focus on the genre demands of popularization discourse, awareness of academic writing conventions, the genre change between academic and popularized writing, the role of the student as a writer, and stylistic attributes.

Keywords: baseline assessment; popularization discourse; student writing; science communication; higher education



Sterk, F.M, Van Goch, M.M., Burke, M., & Van der Tuin, I. (2022). Baseline assessment in writing research: A case study of popularization discourse in first-year undergraduate students. *Journal of Writing Research*, 14(1), 35-76 -<https://doi.org/10.17239/jowr-2022.14.01.02>

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1. Introduction

As seen from the field of linguistics, popularization skills deal with the genre demands of popularization discourse. Popularization is a process of remodeling academic discourse into understandable text accessible to a non-academic audience. In discourse studies, the process of popularization is not merely defined by textual features, but also through social characteristics (Calsamiglia & Van Dijk, 2004). As Myers (2003) suggests, “[p]opularization is a matter of interaction as well as information; it involves persons and identities as well as messages” (p. 273). Although in the “dominant view” of popularization, scientific and popularized discourse are seen as two distinct genres, they are in fact part of the same spectrum of genres (Myers, 2003). Yet, in terms of textual features, popularization discourse is described as a product of the recontextualization and reformulation of academic discourse via which knowledge produced by the academic community is represented for a lay audience and formulated in an understandable way (Calsamiglia & Van Dijk, 2004; Gotti, 2014; Hyland, 2010). Recontextualization is a process of representing scientific knowledge in a new, non-specialist context, and in a manner understandable to a lay audience (Calsamiglia & Van Dijk, 2004; Hall et al., 1999 in Ciapuscio, 2003). Reformulation implies a necessary “redrafting” of the language used (Gotti, 2014). These two processes together construct the textual strategies, or in other words, genre features, that are emblematic of popularization discourse. They include, but are certainly not limited to, contextualization of the research, presenting the main findings, explanation, the use of examples, imagery, and references to the reader.

Popularization training – i.e., training in science communication or science journalism skills – is a new and largely undiscovered research topic.^o Only a decade ago it was noted that despite the importance of training in science communication, such training was largely absent and thus it urgently needed to become part of university curricula (Besley & Tanner, 2011; Brownell, et al., 2013b; Heath et al., 2014; Latimore et al., 2014). Indeed, more recently, programs offering such training have started to appear. These courses, which cater for undergraduate and graduate students, scientists, or science communication practitioners, focus not only on practical skills, but also on the broader context in which science communication is performed (Baram-Tsabari & Lewenstein, 2017; Besley & Tanner, 2011). Research from Besley and Tanner (2011) indicates that 57% of science communication experts provide formal communication training in some form. However, as Hundey et al. (2016) claim, graduate students face a lack of opportunities in which to put their science communication training into practice. Furthermore, insights from experts into the essential elements of science communication courses for post-graduate students also underlined the need for science communication courses to be offered in higher education (Bray et al., 2012). Others report on the results achieved

by courses (McKinnon & Bryant, 2017; Mellor, 2013) or entire science communication Master programs (Trench, 2009) that have been up and running for some time. These studies focus upon the employment of graduated students; their results underpin the importance of explicit training in science communication in ensuring career opportunities in (science) communication jobs. While the above-named sources clearly demonstrate progress is being made, the field remains very much new and evolving.

An enduring deficiency in the field of science communication research is the way in which popularization training research is methodologically constructed. There is a lack of baseline assessments and pretests in intervention research. Not only does this mean that such training does not match students' needs, but it is also impossible to obtain meaningful insights into the development (or not) of skills as a consequence of training. It is for this reason that we draw the topic of popularization training into the field of writing research. Importantly, this paper intervenes both in the methodology and the knowledge base of the science communication research field, offering insights into a case study of popularization writing skills in undergraduate students. In the following section, we juxtapose intervention studies in the science communication field with the methodological options found in writing research.

2. Intervention research in science communication versus writing research

2.1 Methodological gaps in science communication research

In recent years, courses or assignments in science communication from educational practice have been used in case study research to explain the effects of popularization training in undergraduate or graduate training settings. Although some of the courses researched focus solely on speaking skills (Cirino et al., 2017; Whittington et al., 2013), most were developed to teach writing skills (Boynton, 2018; Brownell et al., 2013a; Bruno & Vercellesi, 2002; Moni et al., 2007; Poronnik & Moni, 2006; Rakedzon & Baram-Tsabari, 2017; Sivey & Lee, 2008). Other courses focus on a combination of the two skills (Heath et al., 2014; Kloeppe, 2017; Latimore et al., 2014; Mercer-Mapstone & Kuchel, 2016; O'Keeffe & Bain, 2018; Yeoman et al., 2011). It should be noted that all the above studies are rooted in STEM fields. Looking more deeply we find that, while some studies have merely offered a description of a given science communication course and the educational choices made in developing its curriculum (Bruno & Vercellesi, 2002; Kloeppe, 2017; Sivey & Lee, 2008; Whittington et al., 2013), others focus specifically on the *effects* of the explicit teaching of science communication skills. For some of these courses, their effectiveness is based solely on the self-reporting of participating students, who evaluate: their ability to communicate science (Brownell et al., 2013a); learning gains (Cirino et al., 2017);

confidence levels in science communication skills (O’Keeffe & Bain, 2018); and development of employability skills (Yeoman et al., 2011). In other sources, in addition to self-reporting, an assessment is made of student output – for example, in the form of popular science articles (Boynton, 2018; Heath et al., 2014; Mercer-Mapstone & Kuchel, 2016), outreach experience plans (Latimore et al., 2014), or opinion editorials (Poronnik & Moni, 2006).

The majority of these studies offers insights that are both positive and in agreement with one another. Self-reporting shows that self-perception of (popularized) writing skills, science communication skills, and overall communication skills is high or has increased as a result of teaching, that confidence in communicating science has also increased, and that students found the course useful (Boynton, 2018; Brownell et al., 2013a; Cirino et al., 2017; Heath et al., 2014; Latimore et al., 2014; Mercer-Mapstone & Kuchel, 2016; Moni et al., 2007; O’Keeffe & Bain, 2018; Poronnik & Moni, 2006; Yeoman et al., 2011). However, even though these studies shed light on the way in which educational programs are applied, their reliance on data obtained via self-reporting is problematic, not least as the individual self-perception of skill level cannot alone be trusted to offer a clear indicator of the actual skill level possessed.

Notwithstanding the above, studies that utilize the assessment of writing products indicate that popular science writing skills increased with training (Rakedzon & Baram-Tsabari, 2017); that students’ written texts are assessed on average to contain only minor faults (Mercer-Mapstone & Kuchel, 2016); and that their ability to write a popular genre-specific text increased (Heath et al., 2014; Latimore et al., 2014; Moni et al., 2007). The only dissenting voice here was that of Boynton (2018), whose work displayed mixed results regarding the way students apply genre features of popular science in their writing. Generally speaking, the studies demonstrate the positive effects of science communication training and/or the positive results that stem from participation in a science communication course.

However, one of the prevailing issues with most of the studies described above is their lack of a pretest or baseline assessment. In practice, the assessment of grades and skills in these studies is based solely on post-intervention measurements (Boynton, 2018; Brownell et al., 2013a; Cirino et al., 2017; Heath et al., 2014; Latimore et al., 2014; Mercer-Mapstone & Kuchel, 2016; O’Keeffe & Bain, 2018; Poronnik & Moni, 2006; Yeoman et al., 2011). While some studies apply pre- and posttest surveys geared towards the development of students’ self-perception of skills (Brownell et al., 2013a; Cirino et al., 2017; O’Keeffe & Bain, 2018; Poronnik & Moni, 2006; Yeoman et al., 2011), others apply either a post-course survey (Heath et al., 2014; Mercer-Mapstone & Kuchel, 2016), or assessments throughout the course (Latimore et al., 2014). Because they lack the appropriate data to make inferences about skill development, such studies can, at best, only offer insights into the current state of

students' popularization skills, or into changes in self-perception following a teaching intervention.

In our review of current literature, we encountered two studies that used a pretest and two studies that used a baseline assessment. A pretest was used in Rakedzon and Baram-Tsabari (2017) and Moni et al. (2007). Rakedzon and Baram-Tsabari (2017) used a quasi-experimental design to assess improvement in academic and popular science writing in L2 (post-)graduate students. Identical pre- and posttests required students to write texts for an academic and a general audience, which were assessed using a popular science writing rubric. Moni et al. (2007) used a pretest-posttest design to assess improvement in undergraduate students' ability to write for a lay audience. However, in this instance, the pre- and posttests were not identical: students wrote a communication assignment to establish their baseline writing skills, after which the text-type Opinion Editorial was explicitly taught and assessed in a posttest using an assignment-specific rubric. Studies by Shivni et al. (2021) and Mercer-Mapstone and Kuchel (2015b) utilized a baseline assessment. Shivni et al. (2021) described the baseline of science communication skills in students of an undergraduate environmental science course, although the baseline is tested pre-course, not pre-program. Participation in this study consisted almost exclusively of higher-year students, and a range of media types was assessed. In another study, Mercer-Mapstone and Kuchel (2015b), rather than the baseline of skills themselves, discussed the baseline of how communication skills are taught and assessed in undergraduate science training in Australian universities.

In the context this paper, the studies cited above are the exception to the rule, and although they do provide insights into the development of popularization writing skills and the baseline of science communication skills, the overall use of pretests or baseline assessment in intervention research has not been institutionalized in the research field of science communication.

2.2 Pretests versus baseline assessments in writing research

If the research field of science communication is to make a robust assessment of the development of writing skills, a methodological step first needs to be added and, with this in mind, it is to the field of writing research that we turn to give greater insight into two methodological choices available to test skills pre-intervention: the pretest, and the baseline assessment. Pretests are administered pre-intervention and used to offset posttest results from that same intervention. Baseline assessments are usually conducted at the start of an educational program and can include both an assessment of skills and the broader educational context. Overall, in the context of writing research, the current literature suggests a pretest-posttest design is employed more often than a baseline assessment. In this section we discuss both forms to show the different ways in which baseline writing skills can be tested.

2.2.1 The use of pretests

Typically, pretests are used to compare pre-intervention and post-intervention skills. A methodological design often employed is the pretest-posttest experimental or quasi-experimental design (see Kuiper et al., 2017; Rietdijk et al., 2017). An example of such a study is that of Early and De Costa (2011), who researched the effect of genre-specific instruction in the context of writing college admission essays. An identical pretest-posttest assignment asked students to write an essay responding to a college admission prompt. Pretests are also used to check the reliability of the study – as is the case in Van Drie et al. (2015), who tested the impact of general versus disciplinary-specific writing instructions. A pretest argumentative essay writing task was used, not only to sort high-school students into weak and strong writers, but also to compare the cohorts and test-conditions. Boettger (2014) researched the explicit teaching of technical genres in undergraduate L1 learners. A pretest – consisting of writing a memo discussing the academic major, desired career, and the type(s) of writing students would like to encounter – was used to determine the differences between groups. These studies typically focus on the development of writing skills between the pre- and posttests.

Pretests are also used in testing skills associated with, or of influence on, writing skills. Braaksma et al. (2018) used multiple pretests – an aptitude test, self-efficacy test, and the drawing of a concept map – to pretest content knowledge in a study into the effects of hypertext writing. Luna et al. (2020) pretested the number of arguments found in a source text in a study about argumentative writing instruction for undergraduate students. In other cases, studies include other variables next to student performance, for example, the professional performance of teachers. In such a case, pretesting can also include multiple variables from classroom practice (Rietdijk et al., 2017). While these studies do not focus on writing skills specifically, they do shed light on conditions related to writing competency. Within these designs, variations are possible, see for example Bouwer et al. (2018) regarding an effect study of an instructional program in upper elementary schools, which used a switching replication design in which two groups were tested on three occasions and switched between intervention and regular teaching between tests. In this way, the two acted as each other's control group, additionally creating the possibility for a delayed posttest for one of the groups.

Still, pretesting is not universally employed in writing research. A meta-analysis on writing intervention research in elementary schools from Koster et al. (2015) showed that 34% of studies used a posttest-only design. Furthermore, 47% used a pretest-posttest design with the posttest immediately following the intervention, instead of employing a delayed posttest, which Koster et al. deemed better suited to make claims about long-term effectiveness. Graham and Harris (2014) advocated the use of pretesting in writing intervention studies. They noted that earlier research by Graham and Perin (2007) showed pretests were used in only 57% of studies in a meta-analysis on writing instruction for high-school students.

2.2.2 The use of baseline assessment

Baseline assessment is used to measure skills before the start of an educational program. Baseline assessments offer a description of the attributes of an educational context before a certain change or intervention is implemented (Wall & Horák, 2007). Kyriakides (1999) identified four goals of baseline assessment: to identify the learning needs of the student, as a summative assessment, to identify students with learning difficulties, and to measure educational progress. Instruments often employed in baseline assessment are interviews, observations, performance tests or tasks, and self-assessments (see Bromley et al., 2007; Nutbrown, 1999; Tymms, 1999; Wall & Horák, 2007; Wilkinson et al., 2001). The results obtained from baseline assessments are not only used to shape educational programs but can also be used to tailor teaching to individual needs (Kyriakides, 1999). Although baseline assessments could help in the development of new educational material, when used in isolation they cannot measure a change in outcome or performance (Wall and Horák, 2007). Baseline assessments are thus administered to investigate an educational context pre-intervention, or to identify the skills and needs of students at the start of an educational program.

This type of study, however, seems to be employed predominantly in elementary school settings. Indeed, the use of baseline assessment in a higher education setting is scarce. A prevalent strand of research was produced in the UK context in the late 1990s/early 2000s, where baseline assessment in elementary schools was part of national policy. In the United Kingdom, baseline assessment has been used both as an assessment tool, and in curricular design (see Nutbrown, 1999; Sammons & Smees, 1998; Tymms, 1999; Wilkinson et al., 2001). A study by Bromley et al. (2007) examining self-assessment as a tool of competence in transferable skills for PhD students is one of the few studies on baseline skills conducted outside of an elementary school setting. For our purposes, and in the context of this paper, it is important to note that, to date, no studies have been conducted at the start of higher education programs to give insight into popularization writing skills.

To conclude, both methodological choices can yield useful insights into baseline skills. Pretests are generally used to compare writing skills pre- and post-intervention, to check the reliability of a given study, or to test skills associated with writing skills. Baseline assessment is used to describe multiple facets of an educational setting before the introduction of an intervention. Such facets can include student learning needs, learning difficulties, and educational progress. A notable difference between them emerges in the way in which pretests are frequently used to offset posttest results – which are often given center stage in pretest-posttest studies – while in baseline assessments, the focus is solely on pre-training skills.

2.3 The aim of this study

The general lack of pretesting and almost total lack of baseline assessment into popularization skills in science communication research present two interrelated problems: a gap in both knowledge and methodology. First, a gap in knowledge exists, as the aforementioned studies can only show the level of skills post-intervention. The level pre-educational program/pre-intervention, or indeed any change in skills, is unknown. Therefore, it becomes impossible to effectively tailor training to meet the needs of students. Second, a methodological gap becomes visible. If intervention studies in popularization discourse do not consistently apply baseline assessments or pretests, then no clear methodological framework will be formed about how the baseline of skills can best be measured, nor will it be updated according to the current state of the art. These deficits in knowledge and methodology are also emblematic of a larger issue, namely that (quasi-) experimental intervention studies comprise an underexposed topic in the research field of science communication. Combined, they negatively impact not only educational practice, but also the ability of students to meet their learning objectives.

As was shown in the literature review, the baseline assessment of popularization writing skills is currently almost non-existent. Therefore, in this study we employ precisely this approach. Furthermore, because we want to focus purely on the skill levels exhibited by students at the start of their educational program, we implement our research pre-training. This study is part of a larger project that aims to develop educational material for popularization writing skills in undergraduate programs. The insights drawn from this study will provide input for the development of further educational material.

The aim of this study, therefore, is twofold: first, we want to contribute to the *theoretical base* of the science communication research field by gaining more insight into the baseline of popularization writing skills of students at the start of their educational program in a setting without explicit teaching in popularization discourse. Second, we want to contribute to the *methodology* of the field by showing that baseline assessment can be used effectively when developing an educational trajectory for popularization. The questions that we will answer in this paper are:

1. What is the baseline of popularization skills in undergraduate students who have just started their educational program?
2. What insights can a baseline assessment give for the development of an educational trajectory for popularization writing?

In the following section, we will discuss the methodological choices of the baseline assessment, and its analysis using a coding scheme. Section 4 will outline the main

findings from the text analysis, which are then used to answer the two research questions in section 5.

3. Methods and materials

3.1 Context

3.1.1 Aim of the study

The aim of this study is to assess the baseline of popularization skills in first-year undergraduate students. To do so, we aim to construct a corpus of science communication texts written by these students.

3.1.2 Target group

Participants for this study are first-year students from the undergraduate program Liberal Arts and Sciences at Utrecht University, the Netherlands. Liberal Arts and Sciences is a program that combines liberal education with training in interdisciplinary research skills. Every student chooses their own disciplinary specialization (major) and completes 30 EC in general education (courses outside their disciplinary specialization), as well as 30 EC in interdisciplinary research skills. The main language of lectures, tutorials, and writing assignments is Dutch, while students primarily read textbooks and papers in English. This means students need to have a command of both languages – to speak and write (Dutch) and read (English) at an academic level. The cohort of first-year students from the 2018-2019 academic year consisted of 234 students, of which 140 participated in the study (30 male, 110 female, mean age = 19.53, SD = 1.17, range = 17-24). The chosen cohort met our condition of a minimum level of academic training received. Furthermore, the chosen program ensured the testing of baseline skills across disciplinary backgrounds.

3.1.3 Contextual factors

The Liberal Arts and Sciences curriculum contains four core courses on interdisciplinary methodology, the first of which is The Writing Academy, a level-one undergraduate course that runs twice in the first semester of the academic year. It is a writing-intensive course that focusses on academic essay writing and academic skills. It also lays the foundation for further courses in interdisciplinary research skills by teaching students how to make connections between texts from different disciplinary backgrounds. The goals of the course are learning how to critically and creatively read and write; how to integrate different perspectives about a given phenomenon; how to give and work with constructive criticism; how to discuss and behave according to academic norms and values; and how to work with at least one recognized academic referencing style. Unfortunately, the full

schedule of the course meant research could not be conducted earlier than week four. Therefore, students had already received writing instruction about academic essays – a text type that shows some links with science communication and science journalism.

3.1.4 Delivery of the study

The research was supervised by the teachers delivering the seminars (eight teachers spread across eleven seminar groups, one of whom was the first author of this study). This approach was chosen to ensure balance, as the multiple seminar groups were scheduled simultaneously. Teachers received consent forms, a list of pseudo-anonymized codes, copies of the academic source text, the writing assignment, and research forms for students who did not (or were unable to) bring a laptop to class. In order to standardize the procedure between groups, teachers also received a set of written instructions. These instructions contained information about the research goal, placement within the course, background information about the research, a step-by-step protocol for how to conduct the research, and an explanation of how to debrief. The protocol consisted of steps to take before the research (such as sending out a reminder to students regarding preparation), steps to take during the research (such as the instructions to read out, how to ensure pseudo-anonymity, how to keep track of time, and how to work with students who did not bring a laptop to class), and steps to take at the end of the research (such as checking if consent forms were filled in correctly, and keeping track of the submission of writing assignments). The debrief consisted of questions and discussion points intended to facilitate a plenary discussion about the content of the academic source text and the text genre.

3.2 Procedure and materials

We used the source text “#Sleepyteens: Social media use in adolescence is associated with poor sleep quality, anxiety, depression and low self-esteem”, by Heather Cleland Woods and Holly Scott. It describes an empirical study of the influence of night-time social media use and emotional investment in social media on sleep quality, anxiety, depression, and self-esteem in teens (Woods & Scott, 2016). It was chosen from a pre-selection of 15 academic texts that adhered to our inclusion criteria: a maximum of seven pages in length; clear structure; understandable use of statistics; a topic connected to the theme of the course; and content with a real-world application. Participants read the text in their own time, before the seminar.

During the seminar, participants were first asked to fill in a questionnaire with items on a 1-5 Likert scale, with 1 being the lowest value (‘do not agree at all’) and 5 the highest (‘highly agree’). This showed that on average, participants rated their overall preparation 3.02, time spent on reading the academic article 2.95,

understanding of the content of the academic text 3.81, and interest in its topic 3.74. This means that participants moderately agreed that they were well prepared and had spent enough time reading the article, whilst they agreed that they understood the content of the text and were interested in the topic.

Participants were then given a writing assignment, which asked them to write a journalistic text about the Woods and Scott publication. It had to be written in Dutch, be within a 400-word limit, and publishable in the science section of a Dutch quality newspaper. The target audience consisted of all readers who are interested in science but have not necessarily received higher education. The goal was to write a text that would interest the readers and present the information in an understandable way. Participants were allowed to consult the original text and look up information online. We asked participants to imagine themselves as the authors of the publication by Woods and Scott, as this would enable them to write a science communication text (popularization by the researcher) instead of a science journalism text (popularization by a journalist). This was done because the overarching aim of the educational program is for students to become more proficient at communicating the aims, practice, and results of their own research. Finally (although this is not discussed further in this paper), participants were asked to complete a short questionnaire with items pertaining to self-assessment of their written product and writing skills. The time limit for writing the science communication text and filling in the two questionnaires was set at one hour.

Research data were collected in accordance with guidelines of the faculty's Ethics Assessment Committee. To obtain informed consent, an information letter was uploaded to the online course environment at the start of the course. Participants were asked to fill in a consent form during class. The information letter, consent form, and instruction given by the teachers all explicitly stated that participation in the study would not impact students' grades and that participation was voluntary. Every student received a code with which to pseudo-anonymize their assignment.

3.3 Coding scheme

We developed a scheme to code textual features, or strategies, of popularization discourse. Here, we will give a short overview of the coding scheme and its development. See (Sterk et al., forthcoming) for more information.

For the construction of the coding scheme, we used part of the corpus also used for this study. All texts are based on the same source text, meaning their content and the strategies used in them are easily comparable to each other and to the academic text. We worked in seven rounds, using descriptive coding (Saldaña, 2015) as a first cycle method to code randomly selected texts – ten per round, which were switched every two rounds. We also used consensual coding (Schmidt, 2004), in which we independently analyzed and then compared coding, and discussed

difficulties and uncertainties, differences in coding, emerging codes, and superfluous codes. In the first round, Luzón's (2013) empirically constructed list of rhetorical, recontextualization, and linguistic strategies used in science blog posts was employed as an a priori list of codes, which was further adapted after each round. In the seventh round, the ten texts that had led to the most disagreements in earlier coding were recoded as a final check. We checked the inter-rater reliability after each round, calculating percent agreement, Cohen's kappa, and its 95% confidence intervals following McHugh (2012). After round seven, the inter-rater agreement had reached a kappa of 0.9 with confidence intervals of 0.86 to 0.95, which relates to an almost perfect level of agreement. We used pattern coding as a second cycle coding technique via which to thematize the strategies, in part using themes from Hyland's (2010) framework on proximity.

To counteract the possible effects of using a corpus that was based on a single academic text and written by students, a validation round was conducted. We used a corpus of 38 popularization texts written by professionals from different science journalism outlets based on Berezow's (2017) infographic on the quality of science news reporting. This corpus thus contained texts about many different topics written in many different writing styles. The focus in coding was on the use of existing strategies and the occurrence of additional strategies. Through this validation step, a final five strategies were added to the coding scheme.

Table 1 details the strategies in the coding scheme, which consists of five themes that are considered important in current literature on the popularization of academic discourse. Subject matter contains the rhetorical strategies that are part of the popularization text (Luzón, 2013). They usually have a focus on the object studied and use a "narrative of nature" (Hyland, 2010, pp. 120-121). Tailoring information to the reader means that the academic content and discourse need to be recontextualized for a non-academic audience (Gotti, 2014). Credibility is constructed by focusing both on the credibility of the source (i.e., the researcher), and personalization strategies (Hyland, 2010). Stance is used in two ways, not only to form an opinion about the scientific community (Calsamiglia & Van Dijk, 2004), but also to establish proximity with the reader (Hyland, 2010). Engagement establishes a connection with the reader: by reformulating academic discourse into informal discourse that is geared towards the reader, the writer can attract the attention of the reader and connect to them (Hyland, 2010; Luzón, 2013).

3.4 Analysis

Data for this study were gathered qualitatively through text analysis in two rounds of descriptive coding (Saldaña, 2015). The first round of coding was conducted by the first and second author using the coding scheme as an a priori list of codes. In the second round of coding, the first author sub-coded the references in each strategy to characterize their use. Texts were coded in NVivo® (QSR International

Pty Ltd., Version 12, 2018). The breadth of coding was compliant with the size of a strategy and could range from a single word to multiple paragraphs.

Table 1. The coding scheme of popularization strategies

Theme	Strategy
Subject matter	Lede
	Contextualize the research
	Announcing the new finding or new contribution to the discipline
	Novelty
	Describing the method
	Presenting and explaining results/conclusions
Tailor information to the reader	Applied implications
	Explanations
	Imagery
	Examples from daily life
	Hyperlinks
	Visuals
Credibility	Scientific implications
	Mentioning more research is necessary/next step in research
	Contribution of the research to science
	Mention of statistics
	Giving the researcher an active voice/direct quotes from the researcher
	Lexical mention of the original research
	Additional sources
	Link to the academic publication
	Direct quote from the academic publication
In-text specification of a source	
Stance	Opinion
	Stance markers
Engagement	Titles/subheadings
	References to popular lore and beliefs, and popular culture
	Self-disclosure of the author's public or personal life
	Inclusive pronouns
	References to the reader
	Giving non-researchers an active voice/direct quotes
	Features of conversational discourse
	Questions
	Humor
	Explicit self-reference

We checked the inter-rater agreement by both scoring the same 10% of the texts. We checked consistency in coding, both on the level of strategies and of coding size. Our inter-rater agreement on the level of strategies had a kappa of 0.89 with 95% confidence intervals of 0.84-0.93. The inter-rater agreement on the level of size of coding was calculated per strategy with scores weighted by length of texts (see Table 2). Although most kappas are within an acceptable range, scores overall range between 0.35 and 1.00. The lower kappas reflect those strategies that led to more issues throughout coding. Part of these lower scores can be attributed to a relatively low number of texts analyzed for inter-rater reliability. Some strategies were only coded a few times, so that a single difference in coding strongly impacted the kappa.

4. Results

Participants produced texts that averaged 298 words in length. Three participants noted at the end of their text that they had been unable to finish writing it, whereas one added their computer had crashed, thus forcing them to retype. One submission contained a title, but no text. Two texts were written in English and fourteen texts were longer than 400 words; these were included in the analysis. Six participants were unable to bring a laptop and wrote their texts on paper; their research data were digitalized before analysis.

Table 3 displays a quantitative representation of the use and coverage of each strategy. In sections 4.1 to 4.5, a short qualitative assessment is given for the match of each strategy to its definition in the coding scheme. An example of each strategy can be found in Supplement 1.

Table 2. Weighted inter-rater reliability (kappa) per strategy

Strategy	Weighted kappa	Number of texts a strategy was coded in
Subject matter	.72	14
Lede	N/A	0
Contextualize the research	.90	12
Announcing the new finding or new contribution to the discipline	.96	13
Novelty	.43	8
Describing the method	.92	10
Presenting and explaining results/conclusions	.84	14
Tailor information to the reader	.76	13
Applied implications	.72	9
Explanations	.57	3
Imagery	.82	6

Examples from daily life	.84	9
Hyperlinks	N/A	0
Visuals	N/A	0
Credibility	.86	14
Scientific implications	1.00	1
Mentioning more research is necessary/next step in research	.76	4
Contribution of the research to science	.94	1
Mention of statistics	.84	6
Giving the researcher an active voice/direct quotes from the researcher	N/A	0
Lexical mention of the original research	.97	9
Additional sources	N/A	0
Link to the academic publication	N/A	0
Direct quote from the academic publication	N/A	0
In-text specification of a source	N/A	0
Stance	.68	12
Opinion	.73	5
Stance markers	.51	12
Engagement	.67	15
Titles/subheadings	.99	13
References to popular lore and beliefs, and popular culture	.35	2
Self-disclosure of the author's public or personal life	N/A	0
Inclusive pronouns	.55	4
References to the reader	.59	6
Giving non-researchers an active voice/direct quotes	N/A	0
Features of conversational discourse	.56	11
Questions	.99	8
Humor	.99	2
Explicit self-reference	.66	1

Table 3. Results on the level of popularization strategies

Theme	Strategy	Texts that use the strategy	Coverage in texts that use the strategy	Coverage in texts overall
Subject matter	Lede	0.0%	0.0%	0.0%
	Contextualize the research	79.3%	21.6%	17.5%
	Announcing the new finding or new contribution to the discipline	90.0%	11.1%	10.1%
	Novelty	54.3%	19.4%	10.9%
	Describing the method	71.4%	18.5%	13.6%
	Presenting and explaining results/conclusions	98.6%	59.4%	59.2%
	Tailor information to the reader	Applied implications	47.9%	13.9%
Explanations		21.4%	7.5%	1.7%
Imagery		27.1%	3.3%	1.0%
Examples from daily life		52.1%	14.8%	8.0%
Hyperlinks		0.0%	0.0%	0.0%
Visuals		0.0%	0.0%	0.0%
Credibility	Scientific implications	0.7%	11.8%	0.1%
	Mentioning more research is necessary/next step in research	23.6%	10.8%	2.6%
	Contribution of the research to science	11.4%	11.2%	1.4%
	Mention of statistics	38.6%	0.7%	0.3%
	Giving the researcher an active voice/direct quotes from the researcher	0.0%	0.0%	0.0%
	Lexical mention of the original research	65.7%	3.3%	2.2%
	Additional sources	8.6%	11.0%	1.1%
	Link to the academic publication	0.0%	0.0%	0.0%
	Direct quote from the academic publication	0.7%	25.9%	0.2%
	In-text specification of a source	0.0%	0.0%	0.0%

Stance	Opinion	30.7%	10.6%	3.4%
	Stance markers	71.4%	1.5%	1.1%
Engagement	Titles/subheadings	81.4%	2.4%	1.9%
	References to popular lore and beliefs, and popular culture	10.7%	4.9%	0.5%
	Self-disclosure of the author's public or personal life	2.1%	5.7%	0.2%
	Inclusive pronouns	32.1%	0.5%	0.2%
	References to the reader	30.7%	0.6%	0.2%
	Giving non-researchers an active voice/direct quotes	0.0%	0.0%	0.0%
	Features of conversational discourse	71.4%	20.1%	14.8%
	Questions	39.3%	5.4%	2.3%
	Humor	8.6%	5.0%	0.5%
	Explicit self-reference	12.9%	0.4%	0.1%

Note: The column *Coverage within texts* displays the percentage of characters that were spent on a strategy solely in texts where the strategy was used, with percentages weighed by text length. *Coverage in texts overall* refers to the percentage of characters spent on a strategy throughout all texts, including those in which the strategy was not used. For both types of coverage, the percentage of *characters* is used because NVivo calculates percentages in characters, rather than words.

4.1 Subject matter

4.1.1 Lede

A lede is a short introductory section with a length ranging from once sentence to a (short) paragraph. It is used to establish the most important findings and to attract the attention of the reader. None of the participants use a lede.

4.1.2 Contextualize the research

Contextualization is an organizational strategy used to introduce a topic and attract the attention of the reader, most often used in the first paragraph of the text. Other strategies, such as novelty, examples, anecdotes, and questions are used to construct contextualizations. Participants write contextualizations that structurally consist of a combination of moves reminiscent of an academic introduction (connection to the reader, anecdote, complication, question). Content-wise, contextualizations focus on telephone or social media use generally, or specifically in teens, and on parent-child interactions.

4.1.3 Announcing the new finding or new contribution to the discipline

Announcements focus on the news value of research. They contain an announcement claim and a newsworthiness claim. However, announcements written by participants usually contain an announcement claim plus a content claim. The announcement claim focuses either on the fact that research shows new findings or on the researchers that conducted it (here participants that write from the perspective of the researcher use I or we). Content claims focus on results – presenting (parts of) the main claim or focusing on the research set-up.

4.1.4 Novelty

Novelty shows the motivation for doing research, either by giving an overview of preexisting knowledge, revealing a knowledge gap, or by pointing out why research is necessary. Participants use novelty to point to preexisting knowledge or to express newness, but never to define an existing knowledge gap. Some participants present information from previous research, without making it clear that this information was already presented in the introduction of the source text.

4.1.5 Describing the method

The method is described either on an abstract (hypothesis/goal/topic) or a practical/applied (measured constructs and materials) level. Participants reference the method through different levels of specificity, from an abstract statement to a complete description. The research question and participants of the research are mentioned most, although measured constructs (such as night-time social media use and sleep quality) and materials (for example a questionnaire) are also mentioned.

4.1.6 Presenting and explaining results/conclusions

Presenting results entails showing the information from academic research, which can be presented as new insights and can be explained. Participants present results, but never explain them beyond information already presented in the academic text. Most statements are related to the main claim of the academic text, in which three main causes and four main consequences are mentioned. Many other factors are also mentioned, some of which are not included as a cause/consequence in the academic text. An academic structure is adhered to on sentence level that implies a focus on cause and effect: a meta comment introduces the research, causes are connected to consequences using a relation-marker, and at any point mediating factors are added.

4.2 Tailor information to the reader

4.2.1. Applied implications

Applied implications recontextualize knowledge beyond the scope of science, into everyday life, and readers are sometimes urged to take action. Participants use applied implications either for implications that mention teens and mental health (these implications are often research results that are reformed into implications), or society and parents. Alternatively, applied implications present a call to action to make conscious choices about social media or telephone use late at night.

4.2.2 Explanations

Explanations are used to elaborate upon a term or idea. They consist of paraphrases, reformulations (specialist discourse is presented in more understandable language), explanations of definitions, or elaborations of terms and concepts. Participants use reformulations, abbreviations, or additional information, but only to elaborate upon concepts, never to explain specialist discourse. One often explained concept is FOMO (fear of missing out) – a term only mentioned in the introduction of the academic text.

4.2.3 Imagery

Imagery consists of all types of explanatory elements that use figurative language, such as metaphors, analogies, comparisons, and idioms. Participants use metaphors, personifications, idioms, and similes. The use of imagery is always connected to teens and social media, and sometimes to the research process itself.

4.2.4 Examples from daily life

Examples from daily life create a scenario to draw information into an everyday context in order to explain it. Participants use examples from daily life to recontextualize knowledge from the academic text about social media, telephones, parents, and tiredness. In these examples, participants refer to teens or parent-teen interactions, or use references to the readers or inclusive pronouns.

4.2.5 Hyperlinks

Hyperlinks link to other online sources that contain explanations or additional information. None of the participants use a hyperlink.

4.2.6 Visuals

Visuals attract attention or are used as visual explanatory elements. Visuals can include image captions and credits. None of the participants use a visual.

4.3 Credibility

4.3.1 Scientific implications

Scientific implications present the implications for actors involved in disseminating and publishing research. One participant uses scientific implication in the form of a call to action to further spread the results of the research.

4.3.2 Mentioning more research is necessary/next step in research

Mentioning more research is necessary consists of a mention citing the need for further research combined with an explanation of the next step in that research – although these two components can also be presented separately. Participants sometimes use a standalone remark that more action is necessary, however, more often, explanations are given for why that is so, including scientific or societal reasons.

4.3.3 Contribution of the research to science

The contribution of the research to science highlights the significance of the results for the scientific community or the further development of science. Participants focus on academic contributions and refer to the novelty of the research, the lack of previous research, new insights, or the necessity of the research. Claims about a lack of previous research are factually incorrect as telephone use and social media have both been extensively researched.

4.3.4 Mention of statistics

Statistics are used to underpin the credibility of the research and give insights into the research results. Participants use statistics either to detail the behavior of teens with respect to telephones or the effects this behavior has. The statistics mentioned are almost exclusively taken from the academic text and only used to present results.

4.3.5 Giving the researcher an active voice/direct quotes from the researcher

Direct quotes from researchers are used to establish credibility of popularizations. They are often presented in quotation marks and introduced through “the researcher says”. None of the participants use a direct quote.

4.3.6 Lexical mention of the original research

Lexical mentions are used to signal the credibility of the source, such as the position of the researcher in an academic institution. Participants use lexical mentions referring to the geographical location, the authors, the title of the paper, the academic institution, and the journal title.

4.3.7 Additional sources

Additional sources are used to add information or underpin findings from a different perspective. Participants use additional sources for these two goals. Five participants included additional sources, while seven use sources mentioned in the academic text, but present them as additional sources. In some cases, reference is made to these sources in academic citations.

4.3.8 Link to the academic publication

A link to the academic publication is either presented as an in-text hyperlink or in a separate sentence. None of the participants use such a link.

4.3.9 Direct quote from the academic publication

A direct quote from the academic publication is a one-on-one quote. One participant uses a direct quote twice, presenting it verbatim, including original in-text citations. This quote is used to explain the methodological choice to research adolescents and to present the main claim of the article.

4.3.10 In-text specification of a source

With in-text specification of a source, the author clearly states the origins of information or a quote. None of the participants use in-text specification.

4.4 Stance

4.4.1 Opinion

Opinions consist of any evaluative remark, either positive or negative, sometimes echoing the opinion a reader might hold. Participants use opinions both in favor of the research and to critique it. They only cover academic aspects of the research (mostly results), including their predictability or reliability. Methodological choices and the contribution to science are also often included in opinions.

4.4.2 Stance markers

Stance markers are used to comment on the certainty, doubt, reliability, or the limitations of a proposition. Such markers are also used to identify the source of information and to convey attitudes, feelings, value judgments, or expectations. Participants use stance markers to comment on a wide range of factors – from the value and order of magnitude of the findings of the study to its implications. They are also used to make it clear that new insights align with expectations or deviate from them, although they are used most often to comment on information and hardly ever to convey attitudes or feelings.

4.5 Engagement

4.5.1 Titles/subheadings

Titles and subheadings attract the attention of the reader, for example by presenting (part of) the main claim of the academic text or connecting it to everyday life. Participants mainly use titles that focus on the content and conclusion of the academic article (i.e., social media), and often use part of the academic title “#Sleepyteens”. Some use a more academic register, while others employ more popularized language. In total, four participants used subheadings in addition to titles, while two used subheadings but no title.

4.5.2 References to popular lore and beliefs, and popular culture

References to popular lore, beliefs, and popular culture connect findings from the academic text to the audience’s existing understanding of topics that they have gained through popular culture. Participants’ references to popular culture are related to (technical) aspects of social media, such as cat videos or hashtags, while popular lore is referenced by connecting to widely held beliefs about social media.

4.5.3 Self-disclosure of the author’s public or personal life

Self-disclosure consists of examples from the daily, personal life of the author. Participants use self-disclosure for confessions about their personal life or explanations of personal choices connected to social media use.

4.5.4 Inclusive pronouns

Inclusive pronouns create a shared group between reader and writer in which both parties share the same point of view, or a taken-for-granted view is presented. Participants mostly use inclusive pronouns to make a shared group of writer and reader, or to establish that some action is taken by everyone. They are often used to evoke other strategic moves, such as giving advice or presenting a call to action. Content-wise, these references are always related to social media.

4.5.5 References to the reader

References to readers are second-person pronouns used to represent the readers as actors in the interaction. Participants use references to the reader much like inclusive pronouns: to give information; to state a specific action is taken; or to spur the reader into taking action. As such, references to the reader are often used in applied implications. While in some cases the referent is clear (e.g., teens, the reader), in others it remains vague.

4.5.6 Giving non-researchers an active voice/direct quotes

Where direct quotes from the researcher are employed for credibility, quotes from non-researchers construct engagement and are used to include the perspective of everyday life. None of the participants give non-researchers an active voice.

4.5.7 Features of conversational discourse

Features of conversational discourse consist of any type of everyday language use, which are used to give the feeling of informality. Participants only use conversational discourse in parts of the text that do not detail results. The participants' abundant use (in some cases, overuse) of features of conversational discourse, especially within calls to action and anecdotes that form part of contextualizations, reveals their overall writing style to be inclined towards the use of colloquial language.

4.5.8 Questions

Questions are used to catch the attention of the reader and as an explanatory tool. Participants use questions to attract the attention of the reader, to appeal to their everyday interests, or to formulate a call to action. They are also used as a structure marker to introduce new information.

4.5.9 Humor

The use of humor ranges from light teasing, to irony and sarcasm. In participants' texts, humor is used sparingly. It most often appears in the form of everyday life anecdotes or imagery. The use of humor is always connected to social media use.

4.5.10 Explicit self-reference

Explicit self-reference consists of singular or plural first-person pronouns, which are used to let the writer make their presence known in the text. In some cases, another actor in the text constructs self-reference, for example in a quote. Participants' use of explicit self-reference is in the context of claims about social media use. The only exception is when participants write in the role of the researcher, in which case they are used to talk about methods or results.

5. Discussion

In this paper, a baseline assessment was conducted to determine both the baseline of popularization skills in undergraduate students, and the main components required of an educational program in popularization discourse. Participants were asked to write a science communication text about an academic article. Using a coding scheme for text analysis of popularization strategies, qualitative and quantitative insights were generated.

5.1 Baseline in popularization skills

The first research question asked what the baseline of popularization skills is in undergraduate students that have just started their training. Texts mainly consist of subject matter strategies, with the exception of *ledes*. Especially *results* are used often and consistently throughout the texts. Many strategies appear often, but not consistent throughout the texts, such as *examples from daily life*, *mention of statistics*, *lexical mention of the original research*, and *questions*. Other strategies appear only sparingly, such as *references to popular lore*, *contribution of the research to science*, and *humor*. Strategies such as *stance markers* and *titles* appear often but make up only a tiny fraction of the overall text. How strategies are deployed roughly corresponds with their description in the coding scheme. It is interesting to note here that the use of *features of conversational discourse* moves beyond what would be seen in professional science journalism and appears rather as if participants are having a conversation with their friends. Furthermore, although the use of *contextualizations* matches the description in the coding scheme, their length of up to a paragraph is rather long compared to professional texts that achieve the same in only one or two sentences.

The texts do not adhere to the genre conventions of science communication because they bear no resemblance to newspaper articles, which tend to be written using an inverted pyramid – information is presented hierarchically, from highest to lowest importance. In the participants' texts, the information follows the chronology of the source academic article. Texts contain an introduction (*contextualization – novelty – announcement*), middle (*results*), and conclusion (*applied implications*). *Opinions* and *scientific implications* appear more towards the end of the texts. Strategies are often combined: *examples from daily life* are used in *contextualization*, whereas *lexical mentions* are combined with *methods*. *Explanations*, *imagery*, *statistics*, and all strategies part of the theme engagement (minus *titles/subheadings*) appear throughout the texts, but hardly ever in those passages detailing *results*, which is most clearly visible in the use of *features of conversational discourse*.

An exception to this structural homogeneity is the lack of an *announcement* to delineate between *contextualization* and *results* in some texts. Instead, the textual marker "but" ("maar" in Dutch) in combination with a *question* is used. These texts furthermore present a mix of *results*, background information, and *contextualization*. The writing assignment detailed no information about genre conventions, meaning genre knowledge was tested as much as actual writing skills. In this light, the homogeneity across texts is compelling: if participants lacked genre knowledge, heterogeneity between texts would be more likely.

The content deviates little from the academic text. All texts are firmly rooted in the topic of smartphone use in teens. Some deviations are visible towards parent-child interactions about smartphone use or the reader as a social media user.

Overall, texts rely heavily on information and ideas presented in the academic paper. The addition of participants' own materials, sources, or information is rare.

Not every strategy contains the same options for recontextualization. Some strategies rely on information from the academic text, such as *statistics*, *method*, and *results*. Here, correct representation becomes important. Yet four types of misrepresentations occur. First, truth claims contain misrepresentations, which is most visible in *results*. For example, consequences attributed to social media use are said to occur in adults, whereas the academic text describes consequences in adolescents only. Second, participants treated information in the introduction as *results*, hence misrepresenting background information as research findings. They also represent information from other sources as research findings. Finally, the participants' frame of reference is visible through the attention given to specific topics. Fear of missing out is mentioned twice (albeit briefly) in the introduction of the academic text but is not part of the method or research results. Yet, it is (incorrectly) still included as a measured construct by thirty participants. Seen in a broader context, these misrepresentations demonstrate the way in which participants read academic texts, and how they deal with information and truth claims. More generally, such misrepresentations show how participants think about ownership of information. In these cases, information is simply taken at face value: detached from academic authors, the research they conducted, and the work required to draw appropriate conclusions from research results.

Instead of relying on the academic source, other strategies primarily need writer input, such as *imagery*, *explanations*, *additional sources*, *opinion*, and all strategies part of the theme engagement. In these strategies, it is mostly creativity that is important. A clear delineation is visible between strategies that rely on information from the academic text and strategies that require author input. Both the structure and content of strategies relying on academic source material stick so close to that material that they are essentially academic. An example is *results*, where content (smartphone use) and structure (focus on cause and effect) mirror the academic source. Strategies that rely on writer input, on the other hand, occupy the other end of the spectrum: they are more colloquial than popularized, in parts written as if participants were chatting to their friends. This is shown in the following example, in which *conversational discourse* is used:

New research suggests that we can be more specific about the factors that lead to those consequences. Just in case parents haven't already got enough ammunition to enforce lower telephone use, eh! And anyway, how important can that one nonsense text be after ten o'clock?

The communicative context is ill-defined in most texts. This communicative context should be defined by the actors in the interaction, the roles they play, their

knowledge, and the relevance of this knowledge in everyday life (Calsamiglia & Van Dijk, 2004). In most texts, the actors remain unclear, either as underpinned by implicitness in *references to the reader*, or by a mid-text switch between different actors (teens, adults, parents). Only the inclusion of the academic authors as actors in the form of *lexical references* is unambiguous.

The new and recontextualized context – one of everyday life in which smartphones/social media play an integral part – is not that far removed from the research results, and often successfully created through *contextualization* and *examples from daily life*. This ability to recontextualize is also connected to what Hyland (2010) refers to as proximity, namely the rhetorical features employed to display both authority about a topic and personal interest in it. The combination of *results* (authority) and strategies from the theme engagement (personal interest) – although in other ways responsible for the rift between academic and overly popularized texts described earlier – enables proximity.

5.2 Implications for the educational program

The second research question addressed the insights that may be found from a baseline assessment for the development of an educational trajectory for popularization writing. Following the insights from section 5.1, the following themes can be distinguished.

5.2.1 Genre demands of popularization discourse

Overall, the fact that some strategies are consistently underused, that the structure never follows the inverted pyramid method, and that strategies in the theme subject matter follow the strictness of academic guidelines, shows there is a lack of awareness about the genre demands of popularization discourse. Paying explicit attention to these demands will give students a frame of reference with which to work when writing in this genre. Put simply, if you are unaware of a strategy being acceptable within a genre, you are not very likely to use it. This might also explain, for example, the total lack of *hyperlinks* and *visuals* – two frequently used strategies in popularizations.

5.2.2 Academic writing skills

While paying attention to academic writing to develop popularization skills might feel counterintuitive, many of the issues found stem from a lack of awareness about the nature of academic writing. Underuse of the more academic strategies, such as *contribution of the research to science* or *giving the researcher an active voice*, suggests participants are either unaware that they can be used in popularized writing or simply lack the skills to employ them. Attention to academic writing will also ensure students are aware of the structure required of an academic article. This will help in distinguishing between *results* that are representable in popularized

writing, and background information from the introduction that is less so, as well as with the correct representation of the content and with the attribution of information from other sources.

5.2.3 The genre changes between academic and popular discourse

The recontextualization and reformulation necessary in the genre shift from academic to popularized writing needs specific attention. This includes explicitly teaching the use of *applied implications* as a means to recontextualize the impact of academic research toward everyday life, *additional sources* to offer more information, and *explanations* to offer clarity. Reformulation can be explicitly taught through *inclusive pronouns* and *references to the reader*, to help define the communicative context. Although *conversational discourse* already frequently appears, its use can be improved upon. Texts display a binary character: while some parts are strict and academic, others are colloquial and popularized. Paying attention to the genre switch between academic and popularized discourse can clarify how content- and style-focused strategies are successfully combined. In this manner, the focus might shift slightly from subject matter strategies towards other strategies that enable popularization.

5.2.4 The role of the writer

In most academic writing, the writer and their personal life and opinions remain implicit or even absent. This could explain why strategies such as *self-disclosure*, *explicit self-reference*, and *opinion* are underused. Participants might think they are not allowed to use these strategies. By showing students when and how self-expression as the author is possible in popularizations, they can learn how and when to include details about their own lives and their personal opinions.

5.2.5 Style and narrative

Strategies focusing on style and narrative are already used, such as *humor*, *references to popular lore*, *imagery*, *references to the reader*, *inclusive pronouns*, *mention of statistics*, and *questions*. However, they are employed sparsely and inconsistently. Paying more attention to style, narrative, and attracting the attention of the reader might enable students to add more of their own input and to adhere less strictly to the content provided by the academic source. This will also help to bridge the gap between academic and popularized language use.

Taken together, the five themes set out above may show students how to recontextualize and reformulate academic discourse into popularized discourse. As such, they could provide the basis for an effective educational program in popularization training.

6. Conclusion

6.1 Empirical findings versus the literature

Scarce use is currently made of baseline assessment in science communication research, making any connection to previous studies difficult. The findings of Shivni et al. (2021) in part concur with our own, showing that while students display a consistent degree of science communication skills, there is certainly room for improvement. More specifically, Shivni et al.'s (2021) findings suggest that courses in science communication should pay attention to understanding the audience, targeting narrower audiences, science communication theories, developing various communicative goals, and practicing with multiple media types. Mercer-Mapstone and Kuchel's (2015b) baseline assessment focusses on how communication skills are taught and assessed in undergraduate training. As their focus is on teaching materials instead of student skills, a direct comparison with our findings is impossible.

In two previous studies from the science communication field, a pretest was used. Rakedzon and Baram-Tsabari (2017) used a popular science genre index consisting of the sum of five scoring elements: catchy title, active voice, inverted pyramid structure, journalistic format, and explanation of jargon. Moni et al. (2007) used a mean Flesch Reading Ease (FRE) score to index text complexity from 0 (very hard) to 100 (easy). However, the summing of measures in these pretests makes a direct comparison difficult. Overall, participants perform from under measure to average measure on assessment points, and are thus already somewhat equipped to write popularizations, albeit in need of more training – insights also shared by this study.

The baseline assessment conducted in this study was used to describe the attributes of a specific educational context (see Wall & Horák, 2007) – i.e., the baseline of popularization skills in undergraduate liberal education students. This baseline assessment conforms to one of the four goals identified by Kyriakides (1999), namely that of identifying students' learning needs. However, the results from this study are unsuited to the measurement of *change* in performance (Wall & Horák, 2007). Our future research focusses on retesting (some of) these participants to measure educational progress – another of the four goals from Kyriakides (1999) – in a setting without explicit training. The insights gained from our study act at cohort level because they will be used to shape an educational program. Although we did not report individual results, they could in future still be used to adapt teaching to individual needs (Kyriakides, 1999).

6.2 Limitations

Although the goal was to test participants immediately at the start of their academic training, the earliest possibility was week four of the first or second teaching block.

Therefore, students had already experienced four sessions of *The Writing Academy* and had written one essay – both of which may have influenced their approach to writing. The course teaches academic skills and academic essay writing, using the book *The New Humanities Reader* (Miller & Spellmeyer, 2014). This book employs an essay style that includes a contextualized introduction, a three-paragraph body where common ground is found between different sources, and a societally engaged conclusion, presenting a call to action. Almost all texts in this study adhere to this structure rather than that of a newspaper article, and explicitly taught elements are found in many texts. It is therefore likely that *The Writing Academy* influenced our results.

The wording of the writing assignment influenced texts in multiple ways. Participants were asked to imagine themselves as authors of the academic publication, which complicated the writing assignment. With hindsight, a more obvious choice would have been to ask participants to write a science journalism text instead of a science communication text from the perspective of the researcher. This choice would also be supported by the fact that science journalism and science communication, in large part, require the same skills, and more importantly for the study at hand, the same textual strategies. In total, eleven out of 140 participants wrote their texts as if they were the researchers. They for example stated: “Our research shows that...”. Some texts abstractly referenced the research (e.g., “Research shows that...”), meaning it was unclear from which perspective they were written. The choice for science communication also influenced the use of some strategies. Those participants that wrote from the perspective of the researchers had the strategy *active voice* unavailable, as it is difficult to quote yourself when you are already writing a text from the first person (singular or plural) perspective. It is also more difficult to use *lexical references* such as the researchers’ names. Conversely, that same perspective made *explicit self-reference* easier to use.

Furthermore, the assignment explicitly asked the participants to convey the main findings, which could have put too much focus on *results*. Participants wrote in a Word template with the header “Title”, thereby influencing the use of *titles/subheadings*. Use of this template might have also restricted participants’ use of hyperlinks and visuals. Furthermore, writing a text in Dutch about an English source meant participants not only had to recontextualize and reformulate from an academic to a popular genre, but also translate into another language, which may well have impacted both the presentation of the content, and the use of strategies. While the academic text was rooted in the social sciences, the participants possess a multitude of disciplinary interests. This focus on social sciences research may have also impacted comprehension of the text for some participants.

The broad description of the target audience in the writing assignment might be a (partial) cause for the ill-defined communicative context and non-specificity of

references to actors in some of the texts. It could also explain the underuse of the strategies part of the theme credibility, as participants might either have felt these strategies were inapplicable to this broad target audience, or they did not use them due to confusion regarding the target audience.

Asking seminar teachers to conduct the research provided some further difficulties. First, a couple of mistakes were made in gathering the data. Some participants (4) only handed in their consent form and not their writing assignment and questionnaire. Others still (16) filled out the consent form incorrectly. Only those participants for whom we were able to solve these issues were included in the study. Furthermore, working with eight teachers made it difficult to determine if the research was conducted in exactly the same manner in each seminar group. Although informal deliberation about the implementation of the research did take place, we could also have systematically checked with each teacher, or planned a plenary feedback session.

6.3 Implications

6.3.1 Methodological implications

Currently, the science communication research field is preoccupied with identifying which skills would be best taught (see Bray et al., 2012; Mercer-Mapstone & Kuchel, 2015a), the description of educational material (see Bruno & Vercellesi, 2002; Klopper, 2017; Sivey & Lee, 2008; Whittington et al., 2013), or testing the effectiveness of those materials (see Boynton, 2018; Mercer-Mapstone & Kuchel, 2016; Poronnik & Moni, 2006). However, these steps – identification, description, and testing – are devoid of argumentative power if knowledge about the base level of skills that students possess prior to training is not considered – a statement that is as true for baseline assessment and pretesting, as it is for both educational and experimental settings. In future research, it is paramount that this methodological insight be taken into consideration.

6.3.2 Theoretical implications

Returning to the insight from Myers (2003) presented in the introduction, scientific and popularization discourse should be seen as part of the same continuum, rather than as two distinct genres. Our study clearly shows the connection between the two discourses. However, it also reveals limitations in the popularization and academic writing skills of participants. This could imply that, instead of academic writing and popularized writing being two distinct genres requiring different writing skills, these skills are in fact (inter)related.

6.3.3 Practical implications

Baseline assessment provides insight into student performance and student skills pre-training, so that an educational program and/or educational materials can be matched to meet the individual or collective needs of students. The five implications discussed in section 5.2 form a guiding framework in setting up new educational training for popularization discourse. Indeed, including academic writing skills into our educational program could have been seen as a counter-intuitive step, had we not performed the baseline assessment.

6.4 Future research

Our goal in this study was to determine a baseline of popularization skills in first-year undergraduate students at the start of their academic training to determine what form an educational program in popularization discourse should take. The study reveals five main areas upon which an educational program could focus. A logical next step in research is to develop and test an educational program that fits these themes. Alternatively, research could focus on the way in which popularization skills develop over time in an educational program that does not contain explicit popularization training but does train in academic writing. This way, the influence of training in academic writing on popularization skills can be measured. In future research, previous education should be taken into consideration, including (but not limited to [Dutch]) language and literature education at a secondary level. Skills do not develop in a vacuum, and such training will undoubtedly have an impact on writing skills and genre knowledge.

More generally, in the research field of science communication, future research should focus on further developing the use of baseline assessment studies and should include pretesting in experimental studies. In educational practice, the use of baseline assessment studies should be institutionalized. Baseline assessment is an indispensable tool, both in research and in educational settings.

This study added to the theoretical insights in the science communication research field by showing that even without explicit training in popularization discourse, undergraduate students are to some extent capable of using popularization strategies to recontextualize and reformulate academic discourse. At the same time, a lack in genre knowledge of both popularization discourse and academic discourse becomes visible. In terms of methodology, this study showed the importance of using baseline assessment as it constitutes an important first step in setting up an educational program – in our case one that focusses on popularization discourse and academic discourse genre conventions as much as on the switch between the two.

Acknowledgements

We would like to thank the editor and anonymous reviewers for their valuable feedback, and Clare Wilkinson (UWE Bristol, UK) for her advice about the set-up of this paper. We are grateful to the Liberal Arts and Sciences students who participated in this study and to the teachers who helped to conduct it.

Note

° In this paper, we use sources from the fields of science communication and discourse studies about the discourse of communicating academic insights to non-academic audiences. Both fields use different terminology. Discourse studies uses the concepts (science) popularization or popularization discourse. The field of science communication uses the concepts science communication and science journalism. In this paper, the terminology of the relevant field is used.

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Appendix: Supplement 1

In this supplement, for each strategy an example is given (in italics), as well as a short explanation. If context is added for the example to make sense, the strategy under discussion is underlined.

Table 1. Examples in the theme subject matter

Strategy	Example
Lede	Ledes are not used by the participants.
Contextualize the research	The discussion that grips thousands of Dutch households usually starts off innocently: ‘Hey, sweetie, haven’t you already spent an hour on your phone/laptop/etc.?’ And it ends in timers, endless comments that smartphones are not welcome at the dinner table and checks whether the child is still texting late at night. Of course, parents want the best for their children and want to help them learn to handle the temptations of technological innovation and social media is now part of that in this modern society. In terms of content, the focus is on a parent-child interaction and on smartphone use. In terms of structure, the participant uses an anecdote.
Announcing the new finding or new contribution to the discipline	Research from the university of Glasgow into 467 Scottish teenagers shows that the use of social media can lead to sleep deprivation, reduced self-confidence, and a higher incidence of anxiety and depression. The announcement claim focusses on the research that was conducted and its set-up, whereas the content claim focusses on results.
Novelty	Lately, more research is being conducted into the connection between social media use in adolescents and different aspects of their wellbeing. Increasing evidence is becoming available that social media use is connected to sleep quality, depression, anxiety, and self-esteem issues in teenagers. The novelty points to information from previous studies while also referring to the main claim of the academic text.
Describing the method	Research was conducted amongst 467 teenagers [participants] to observe the effect of social media use [research question].

<p>Presenting and explaining results/conclusions</p>	<p>This is done through a questionnaire [materials] among teenagers aged between 11 and 17 years [participants]. The participants, research question, and materials are described.</p> <p>Research among 467 Scottish adolescents between 11 and 17 years shows that overall and night-time specific social media use, as well as emotional investment in social media, can be connected to poorer sleep quality, lower self-confidence, and higher levels of anxiety and depression. Here the main causes and four main consequences mentioned in the main claim of the academic text are described. Compare the example to the academic original:</p> <p>“Adolescents who used social media more – both overall and at night – and those who were more emotionally invested in social media experienced poorer sleep quality, lower self-esteem and higher levels of anxiety and depression” (Woods & Scott, 2016, p. 41).</p> <p>The structure of claims is shown in the following example: Research shows [meta comment] that night-time use of social media and emotional investment in social media [causes] can be related to [relation between causes and consequences] sleep quality, anxiety, depression, and self-esteem [consequences] in youngsters [mediating factor].</p>
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Table 2. Examples in the theme tailor information to the reader

Strategy	Example
<p>Applied implications</p>	<p>It is important to consider the results of the #Sleepyteens research when we observe our social media behavior. It is unlikely that we will stop using our smartphones because of the results of this research, but it is important that we are aware of the negative effects that social media might have. This call to action mentions that we should make conscious choices about social media. It uses inclusive pronouns to create a shared group, including both reader and author.</p>

Explanations	FOMO, fear of missing out. This means that people worry about missing out on events and activities they see on the social media feeds of friends and acquaintances. Here, the abbreviation FOMO is explained.
Imagery	As a parent, you would not welcome seeing your teenager going out in the evening and spending a large portion of the night surfing in the water. That would be far too dangerous! You can't see very well, you are tired and less alert, and it disrupts your sleep rhythm. Just like surfing on the water, surfing the Internet at night, and especially on social media, is just as dangerous for teenagers. Here a comparison is made between web surfing and water surfing.
Examples from daily life	'Turn your phone off, you won't be able to sleep!' Many parents with teenage or adolescent children will have heard themselves saying this phrase. A parent-child interaction is used to explain an example of everyday smartphone/social media use.
Hyperlinks	Hyperlinks are not used by the participants.
Visuals	Visuals are not used by the participants.

Table 3. Examples in the theme credibility

Strategy	Example
Scientific implications	It is important to further spread the results of this research and to gain them more recognition. This way, the parents of teenagers and others in their environment are aware that these problems exist, and they know where they come from. The scientific implication is used as a call to action to further spread the results of the research – a claim that is made within the context of the wider implications of the research within society.
Mentioning more research is necessary/next step in research	In the future, to be able to properly establish what the influence of social media exactly is on the mood of teenagers, more research will be necessary into the relation between social media and poor sleep quality, anxiety, and depression,

	<p>so they can get appropriate help when they need it, while enjoying all the benefits that social media has to offer. Both a societal and a scientific reason are given to explain why more research is necessary.</p>
Contribution of the research to science	<p>Because social media has not been around for that long, little scientific research has been carried out. The contribution to science made by the research is explained by mentioning a lack of previous research.</p>
Mention of statistics	<p>The research showed that 97% of the 467 participants regularly uses social media, of which 47% show signs of anxiety, 21% signs of depression, and 35% signs of sleep deprivation. This is a simple representation of the way in which the statistical analysis of results is explained in the source text: "Mean scores and standard deviations for each measure are presented in Table 1. 97% of participants indicated that they used social media. 35% of participants were classed as poor sleepers, with a PSQI score greater than 5 (Buysse et al.,1989). PSQI scores were positively skewed, so were transformed – by taking $\log_{10}(\text{score} + 1)$ – to meet normality assumptions for all further analysis. 47% of participants were classed as anxious and 21% as depressed, according to the HADS cut-off score of 8 or above (Zigmond & Snaith, 1983)" (Woods and Scott, 2016, p. 44).</p>
Giving the researcher an active voice/direct quotes from the researcher	<p>Giving the researcher an active voice is not used by the participants.</p>
Lexical mention of the original research	<p>In the research "#Sleepyteens: Social media use in adolescence is associated with poor sleep quality, anxiety, depression and low self-esteem" [title], Heather Cleland Woods and Holly Scott [researchers], researchers at the university of Glasgow [university], researched how the social media use of adolescents can be linked to their mental health. Here lexical mentions include the title of the publication, researchers, and university.</p>

Additional sources	Today, about 90% of adolescents use social media such as Twitter, Facebook, and Instagram (Duggan & Smith, 2013). A source from the academic text is presented as an additional source and referenced through in-text citation.
Link to the academic publication	Links to the academic publication are not used by the participants.
Direct quote from the academic publication	The adolescent is the focus of this research because they represent the generation that has to deal with social media most and that also grew up with it. Furthermore, it is one of the most (mentally) vulnerable periods in your life: 'Adolescence is a vulnerable period where individuals are at risk for low self-esteem (Orth et al., 2015) and the onset of anxiety and depression (McLaughlin & King, 2015).'
In-text specification of a source	In-text specifications of a source are not used by the participants.

Table 4. Examples in the theme stance

Strategy	Example
Opinion	There are enough leads for further research, but it is clear that the use of social media has a strong influence. This opinion comments on the reliability of the results.
Stance markers	An <u>important</u> new aspect that was found in this research. This has a <u>gigantic</u> negative influence. The first example comments on the value of results while the second shows an order of magnitude.

Table 5. Examples in the theme engagement

Strategy	Example
Titles/subheadings	#Sleepyteens, social media influences the wellbeing of teens Burning eyes and sleepless nights The first title relates to the main claim of the academic paper and is written in a more academic register, whereas the second is more journalistic in tone.

References to popular lore and beliefs, and popular culture	<p>Cat videos on YouTube, pictures of food on Facebook, and nonsense messages...</p> <p>Old, grumpy people have believed for years that all that Facebooking and Twittering cannot be good.</p> <p>The first example is a reference to popular culture; the second refers to popular lore.</p>
Self-disclosure of the author's public or personal life	<p>I must admit that I use social media more often than I would want. Luckily, I know that I am not the only one.</p> <p>Self-disclosure is used for a confession about the author's personal life, which is connected to social media use.</p>
Inclusive pronouns	<p><u>We</u> all spend a ridiculous amount of time checking <u>our</u> Instagram feeds or scrolling through a Facebook page, because if <u>we</u> do not, a fear arises in <u>us</u> that <u>we</u> are missing out.</p> <p>In this example an inclusive "we" is used to describe a shared action.</p>
References to the reader	<p>Maybe <u>you</u> will sleep a lot better if <u>you</u> put <u>your</u> phone aside every now and then.</p> <p>Almost everyone between 12 and 25 knows the phenomenon: <u>You</u> lie in bed, and <u>you</u> are staring at <u>your</u> phone or laptop for way too long. <u>You</u> try to go to sleep, but <u>you</u> keep thinking about all the information <u>you</u> need to process, and <u>you</u> fall asleep restlessly.</p> <p>The first example is a reference that is focused on getting the reader to act. The second example makes it clear that a certain action is taken by the reader (but more broadly, by everyone).</p>
Giving non-researchers an active voice/direct quotes	<p>Giving non-researchers an active voice is not used by the participants.</p>
Features of conversational discourse	<p>You will recognize this: Just before going to bed there is a video on YouTube that catches your attention because of its over-the-top title: BECOMING INDEPENDENT PART 2 & HOW TO MAKE BABYFOOD. Two hours later, you are startled from the immersive images of a dancing giraffe wearing sunglasses.</p> <p>Features of conversational discourse are used in an anecdote describing an everyday life example.</p>

<p>Questions</p>	<p>However, what is the influence of the use of social media on the behavior and the emotions of a person? What kind of influence does our phone have on our sleep rhythm? The first example is used to introduce new information, the second to appeal to the reader.</p>
<p>Humor</p>	<p>It has happened to most of us, falling asleep with your phone still in your hand, because you were checking social media just a little while longer. Sometimes we are startled awake because our phone falls on our heads. In this example, humor is used in the form of an everyday life anecdote.</p>
<p>Explicit self-reference</p>	<p>It is better for <u>me</u> to leave <u>my</u> mobile downstairs when I go to bed. <u>We</u> conducted research among 467 teens between the ages of 11 and 17 about the influence of social media, and the conclusion is that social media has a negative influence on the wellbeing of this age group. The first example shows the use of explicit self-reference to talk about social media. In the second example, the participant writes from the researchers' point of view about methodology and results.</p>

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