Computer Supported Argumentation Learning: Design of a Learning Scenario in Academic Writing by Means of a Conjecture Map

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Abstract: In academic writing, the competency to argue is important. However, first-year students often have difficulties to construct good arguments. Advances in natural language processing (NLP) have made it possible to better analyze the writing quality of texts. New tools have emerged which can give students individual feedback on their texts and the structure of their arguments. While the use of these argumentation learning support tools can help create better texts, using them in an academic context also carries risks. Learning scenarios are needed that promote argumentation competency using argumentation tools while also making students aware of their limitations. To address this issue, this paper investigates how a learning design with an argumentation learning support tool can be developed to increase the argumentation competency of first-year students. The conjecture-mapping technique was used, to visualize our assumptions and illustrate the developed learning design. As part of a first design cycle, the learning design was tested with 80 students in seven academic writing classes at the University of St.Gallen in Switzerland. Preliminary findings suggest that the learning design might be helpful to improve the argumentation competency as well as the data-literacy of students (in relation to argumentation tools). However, further research is necessary to confirm or reject our hypotheses.

1 INTRODUCTION

The competence of being able to argue is important in everyday life (Scheuer et al., 2010, p. 2) as well as in a scientific context (Jonassen & Kim, 2010, p. 440). Argumentation provides means by which we engage in the rational resolution of issues, questions, disputes, and problem solving (Jonassen & Kim, 2010, p. 439). In academic writing, argumentation is one of several important competencies to acquire (Seufert & Spiroudis, 2017, p. 5; Becker-Mrotzek & Schindler, 2007). However, for students in their first year, uncertainty appears to be particularly high because students are still in transition from high school to university (Vedral & Ederer-Fick, 2015; Seufert et al., 2021). Students often lack the requirements to write research papers for academic writing (Kruse & Chitez, 2014).

To offer students more guidance in developing their academic writing skills, text production and feedback on produced texts can be an important element of teaching (Seufert & Spiroudis, 2017). However, for the teacher it is often difficult or at least very time consuming to provide individual feedback to each student (Jeong et al., 2019).

As a possible solution, since the 1990's many software tools have emerged that aim to support argumentation (see e.g., Scheuer et al., 2010). Such tools often have the capability to visualize arguments graphically and point out missing connections (Scheuer et al., 2010, p. 12). In this way, these tools can provide individual feedback to each student. Due to the advances of artificial intelligence (AI) and natural language processing (NLP) it has become possible to better analyze the writing quality of texts (Crossley, 2020). In the context of academic writing, new support tools have emerged (Rapp & Kauf, 2018; Strobl et. al., 2019; Burkhard et al., 2022). A very powerful recent tool is chatGPT (see ChatGPT Pro, 2023) that can compose entire texts and also support argumentation (if you ask the chatbot to do so). With ChatGPT, artificial intelligence (AI) has now made

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its way into education in schools and universities. The power of this AI tool has led to widespread concerns that learners are using it to plagiarize assignments by creating essays or exam papers rather than taking the time to develop their own arguments (see e.g., (Sharples, 2022; Marche, 2022; Heilweil, 2022).

For students to make sense of the complementary strengths of such tools (and also to better understand their limitations), the requirements for developing good arguments are likely to increase. To this end, it might be useful to develop *learning designs* that use argumentation tools to foster argumentation competency, but at the same time make students actively aware of the problems and limitations that come with the use of these tools. Considering the identified research desideratum, the following research question should be addressed:

How can a learning design with an argumentation learning support tool be developed to increase the argumentation competency of first-year students?

The objective of the paper at hand is therefore to develop a learning design by using the argumentation support tool *Artist* to foster argumentation competency of first-year students. The tool *Artist* is an adapted version based on the tool *Argumentation Learning* developed at the University of St.Gallen by Wambsganss et al. (2020). The created learning design was tested with 80 students of the University of St.Gallen during a first design cycle in the fall term of 2022. Following an educational design research (EDR) approach by McKenney and Reeves (2018), the goal is to contribute to theory and practice simultaneously.

From a theoretical perspective, the conjectures we have derived about the learning design can be a starting point for further research and discussion, as they highlight the complexity and multiple demands of technology applications in real classrooms (compared to a laboratory setting). From a practical perspective, the paper can serve as a guideline for other researchers who want to implement similar projects and explore the potential of the technology in more detail. It further contributes to a better understanding on how argumentation learning can be designed and implemented in the context of academic writing.

To this end, the paper is structured as followed: Section 2 lays the foundation for our design by elaborating on the theoretical background of argumentation competency for academic writing and how it can be fostered. Section 3 provides information about the applied research design and the methods used. Section 4 describes the learning design to foster argumentation competency of first-semester students. Section 5 gives insights into the testing of the learning design and critically reflects on the chosen approach. Section 6 concludes with some final remarks.

2 THEORETICAL BACKGROUND

2.1 Argumentation Competency for Academic Writing

Argumentation can be defined “as the valid combination between claims and premises” (Rapanta et al., 2013, p. 483). In the philosophy of logic, "validity" is used in different ways, depending on the specific relationship between premise(s) and claim (Gubelmann et al., 2022). With a deductively valid inference, it is not logically possible that the premise is true, while the conclusion is wrong. Deductively valid inferences then divide into inferences that are deductively valid due to the form of premise(s) and conclusion. Such formally valid inferences are the domain of formal logics. Other inferences are deductively valid due to the content, or meaning, of premise and claim. They are usually called materially valid. In addition to deductively valid inferences, there are defeasible valid ones, where the truth of the premise(s) gives reason to accept the truth of the conclusion without guaranteeing it. Many everyday inferences are of this sort, variously called inductions or abductions (inferences to the best explanation). An overview on this terminology is given in Figure 1.

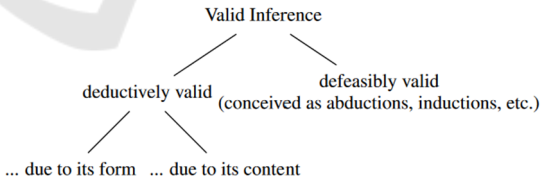

Figure 1: Kinds of valid inferences. Source: Gubelmann et al. (2022).

For education, argumentation competence is considered important, because it is associated with higher-order thinking, helps students to connect information across contexts, separates relevant from irrelevant information and increases the ability of students to explain their knowledge (Rapanta et al., 2013, p. 484). Being able to argue is important in everyday life (Scheuer et al., 2010, p. 2) as well as in a scientific context (Jonassen & Kim, 2010, p. 440). Fostering argumentative activities incorporated in

learning environments support productive thinking as well as conceptual change (Jonassen & Kim, 2010, p. 439). In the context of academic writing, argumentation is an important – though not the only – competency to acquire (Seufert & Spiroudis, 2017, p. 5; Becker-Mrotzek & Schindler, 2007). By explicitly supporting their claims with premises, students examine and reveal their assumptions about knowledge domains, which likely leads to a more relativistic, differentiated view (Jonassen & Kim, 2010, p. 440).

In education, argumentation can be approached from two different perspectives: 1) the *arguing to learn approach* and 2) the *learning to argue approach* (Jonassen & Kim, 2010; Rapanta et al., 2013, p. 486). In the 1) *arguing to learn approach*, "learning emerges as a natural result of an argumentative intervention" (Rapanta et al., 2013, p. 486). An example for *arguing to learn* in the context of academic writing would be, if students peer-review each other's drafts, critically discuss and argue about their texts and learn from that interaction. In the 2) *learning to argue approach*, this relationship is reversed. In this approach, the focus lies on argumentation itself, how it can be fostered as well as its benefits. An example for *learning to argue* in the context of academic writing would be if students learn more about the logic of text structures in order to create more convincing arguments. This paper investigates the topic from the second perspective and adopts a 2) *learning to argue approach*.

Rapanta et al. (2013, pp. 489-491) further distinguish between 1) *argument as form*, 2) *argument as strategy* and 3) *argument as goal*. From the perspective of 1) *argument as form*, arguments are primarily investigated as products consisting of different forms of premise-claim statements. From the perspective of 2) *argument as strategy*, the focus of interest lies "in the procedure of the argument exchange" (Rapanta et al., 2013, p. 491). As arguments are often embedded in a dialogical context, arguments are analyzed from a strategic view based on different argumentative moves (Rapanta et al., 2013, p. 490). Finally, from the perspective of 3) *argument as goal*, the focus of interest lies on the overall discursive process, which traditionally has been persuasion (Walton, 1989; Rapanta et al., 2013, p. 491). The critical discussion in general or the negotiation of content to reach consensus might be other goals of argumentation (Baker, 1999; Rapanta et al., 2013, p. 491).

In this paper, we primarily adopt the view of 1) *argument as form*, which can be represented by Toulmin's argument pattern (TAP) (Rapanta et al., 2013, p. 489). TAP (see Figure 2) is a prominent model of rhetorical argumentation developed by

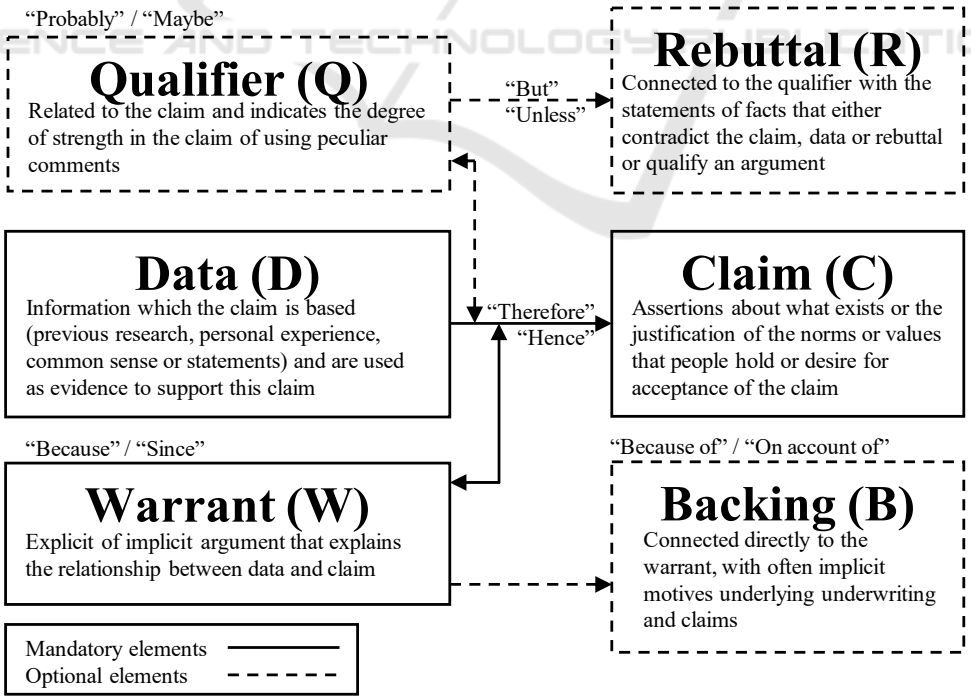

Figure 2: Revised version of Toulmin's argument pattern (TAP). Source: Own representation based on Toulmin (2003, p. 97) and Amhag (2011, p. 4).

Toulmin in 1958 (Jonassen & Kim, 2010, p. 440). According to Toulmin (2003, pp. 89-100), the argumentation model consists of the elements *claim (C)*, *data (D)*, *warrant (W)*, *qualifier (Q)*, *backing (B)* and *rebuttal (R)*. As depicted in Figure 2, an arguer justifies a *claim (C)* by a fact *(D)* which both are linked through a *warrant (W)*, that explains the relationship between the fact *(D)* and the *claim (C)* (Amhag, 2011, p. 4). Additional optional elements can be added, such as the *qualifier (Q)*, which indicates the degree of strength of the relationship through words such as "probably" or "maybe" (Amhag, 2011, p. 4). Other optional elements are the *rebuttal (R)*, which relativizes existing statements using words such as "but" or "unless"; as well as the *backing (B)*, which is linked to the *warrant (W)* and states further implicit motives and assumptions (Amhag, 2011, p. 4).

In addition to the TAP, there exist also simplified argumentation models, which usually only consist of a *claim (C)* and one or multiple *premises (P)* (see e.g., Stab & Gurevych, 2014; Wambsganss et al., 2020). Figure 3 illustrates such a simplified model, where two *premises* (in the TAP they were called *data (D)* and *warrant (W)*) are combined to justify the claim that "Marie Curie is mortal" (see Figure 3).

Our argumentation support tool *Artist* will rely on the simplified model based on claims and premises (see Figure 3) to focus on the most important aspects and make the system as robust as possible. However, for the overall learning design, we will use the TAP (see Figure 2) as a reference framework to highlight contents that our tool *Artist* cannot currently cover. These contents such as the *Backing (B)* can then be discussed verbally by the teacher during the learning scenario to show students the current limitations of our tool and to sensitize them to other important aspects of argumentation.

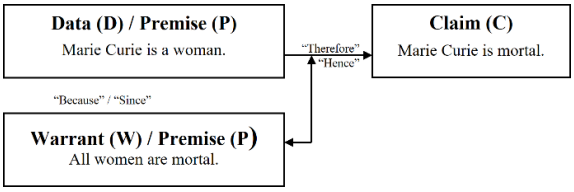

Figure 3: Argument pattern with claim and premise(s). Source: Own representation based on Toulmin (2003, p. 100) and Stab & Gurevych (2014, p. 1503).

2.2 Fostering Argumentation Competency

Regarding a *learning to argue approach*, how can argumentation competency be fostered? According to Jonassen and Kim (2010, pp. 444-454), various methods can be used for developing argumentation competency in the classroom as well as in other learning environments.

First, Jonassen and Kim (2010, p. 445) consider it essential that students engage in meaningful, project-based or *problem-based* learning tasks. In their view, a good learning environment confronts students with a puzzling claim or solution they must resolve.

Second, *counterarguments* should be created by the students in order to better understand opposing positions and adopt a less self-centred more holistic perspective of a given topic (Jonassen & Kim, 2010, p. 445).

Third, *scaffolding elements* can be used to stimulate students' thinking processes by asking topic relevant questions (Jonassen & Kim, 2010, p. 446). The concept of *scaffolding* goes back to the work of Wood et al. (1976), who defined scaffolding as a "process that enables a child or novice to solve a problem, carry out a task or achieve a goal which would be beyond his unassisted efforts" (Wood et al., 1976, p. 90). *Scaffolding* can occur through different channels such as hints, prompts, illustrations, or the provision of feedback (Duffy & Azevedo, 2015). Graphical argumentation aids are widely used (see e.g., Kirschner et al., 2003) to visualize arguments to improve their construction (Jonassen & Kim, 2010, p. 448).

In addition, since the 1990's many software tools have emerged that aim to support argumentation (see e.g., Scheuer et al., 2010). Such tools often have the capability to visualize arguments graphically and point out missing connections (Scheuer et al., 2010, p. 12). These tools can be used to support argument analysis as well as argument generation (Scheuer et al., 2010, p. 13). Depending on the use case, different kind of feedback mechanisms such as *immediate system feedback*, *on-demand feedback*, *summative system feedback* or *moderator-driven feedback* may be appropriate to support the learner (Scheuer et al., 2010, p. 28).

Due to the advances of artificial intelligence (AI) and natural language processing (NLP) it has become possible to better analyze the writing quality of texts (Crossley, 2020). In the context of academic writing, new support tools have emerged (Rapp & Kauf, 2018; Strobl et. al., 2019; Burkhard et al., 2022). For example, the *scientific writing assistant* is able to provide feedback on the overall students' text structure (Turunen, 2013). The tool can draw attention to the fact that certain elements that occur in the text are not mentioned in specific sections (e.g., the abstract); or that some passages (e.g., introduction section) might be relatively too long or too short in comparison to the rest of the text (Turunen, 2013).

The tool *AcaWriter* provides students with a reflective report on their inserted text, highlighting rhetorical moves that are usually used to construct convincing texts (Knight et al., 2020; University of Technology Sydney, 2019). For example, the tool indicates if background information and previous literature on the topic seems to be missing; or if the topic is only treated in a very one-sided way (Knight et al., 2020, p. 153).

Another tool that directly supports argumentation is the application *Argumentation Learning* by the research group around Wambsganss et al. (2020). In a first step, students can insert their own texts. The tool then analyzes the logical structure of the text by identifying argument components (claims and premises), as well as the relationships between pairs of argumentative units (in the same logic as depicted in Figure 3). Moreover, a set of summary quality scores are assessed (readability, coherence and persuasiveness). The results are presented in a learning dashboard through (i) in-text highlighting of the argument components; (ii) graph visualization of the argumentation structure; and (iii) bar-chart visualization of the three quality dimensions. In that way, students receive immediate and personalized feedback that supports them in iteratively improving their argumentation if needed.

The study by Wambsganss et al. (2020) showed in a laboratory experiment that students working with the tool *Argumentation Learning* were able to write "more convincing texts with better formal quality of argumentation" compared to students using a traditional discussion scripting approach based on Stegmann et al. (2012) (Wambsganss et al., 2020, p. 1). In addition, design principles related to the design and development of an argumentation feedback tool (e.g., to provide the learning tool as a web-based application, to provide the learning tool with a visual argumentation and discourse feedback on written or spoken information) have been worked out by Wambsganss et al. (2020, p. 5).

Data-rich environments require a certain level of *data-literacy* to realize their potential in and out of the classroom (Wasson et al., 2016). At the same time, when working with data-rich environments, students can train their data-literacy competency. Data-literacy can involve many different aspects such as the analysis and interpretation of data, understanding problems when using data or the critical reflection about data in general (Bonikowska et al., 2019). Only if students can interpret the data provided by the learning environment (e.g., data visualization, feedback metrics), argumentation support tools can develop their full potential and increase learning gains.

3 RESEARCH DESIGN & METHODS

In this paper, in the context of a 4-year project funded by the Swiss National Science Foundation (SNSF), we will build on the tool *Argumentation Learning* created by the research group around Wambsganss et al. (2020) with the goal of further adapting and improving it to the context of an actual classroom. Compared to a laboratory setting, other contextual factors need to be considered such as the course syllabus or adjusting the learning content to the level of the students. The goal is to create a meaningful teaching and learning scenario using the argumentative writing tool *Artist*.

As methodological foundation for the design and development of the teaching scenario, we follow the educational design research (EDR) approach by McKenney and Reeves (2018). EDR has two goals it simultaneously tries to achieve: On the one hand, EDR makes contributions to theory as it helps to improve the theoretical understanding, which e.g., in the form of guidelines can serve as a building block for the design of future interventions. On the other hand, EDR makes also contributions to practice, as it addresses the problem at hand and provides maturing interventions (McKenney & Reeves, 2018, p. 86). EDR consists of three main processes: 1) *analysis and exploration*, 2) *design and construction*, as well as 3) *evaluation and reflection* (McKenney & Reeves, 2018, p. 77).

The first EDR process, 1) *analysis and exploration* was covered in chapter 2, which introduced important concepts related to argumentation competency for academic writing and how it can be fostered. In addition to that, features of state-of-the-art writing tools in higher education were analyzed and compared, whose findings have been published in a previous paper (see Burkhard et al., 2022).

Building on this knowledge, the second EDR process 2) *design and exploration* will be addressed in chapter 4. In this chapter, the design of the teaching and learning scenario with the argumentative writing support tool *Artist* will be presented. To illustrate our assumptions, structures, processes, and the expected dependencies, we will use the conjecture mapping technique by Sandoval (2014), which can be used to conceptualize educational design research (see e.g., Moser et al., 2021; Boelens et al., 2020; Wozniak, 2015).

The third EDR process 3) *evaluation and reflection* is discussed in chapter 5. In this chapter, the take aways and lessons learned from an initial testing of the designed learning scenario in seven academic

writing classes (in total 80 first semester students) at the University of St.Gallen will be described.

4 ARTIFACT DESCRIPTION: LEARNING DESIGN TO FOSTER ARGUMENTATION COMPETENCY

Figure 4 shows the conjecture map of the designed artifact, a learning design to foster argumentation competency of first-semester university students. From left to right, Figure 4 is arranged into the four components *high level conjectures* (what are the overall assumptions?), *embodiment* (what materials, tasks and structures are needed for the learning design?), *mediating processes* (how does embodiment lead to observable interactions and artifacts?) as well as *outcomes* (what are the desired learning outcomes?).

4.1 High Level Conjectures

In the previous sections 1 and 2, we have already described the *high level conjectures* necessary for our scenario. Based on the overall goal to develop argumentation competency for academic writing (I.), we use a problem-based learning approach (II.) as well as a computer-supported argumentation learning tool (*Artist*) (III.) to foster learning. As important design principles, we rely on the *learning-to-argue-approach* (V.) (see Jonassen & Kim, 2010) as well as on elements that have been found to characterize good argumentation learning tools (VI.) (see Scheuer et al., 2010; Wambsganss et al., 2020, p. 5).

4.2 Embodiment

Regarding the *embodiment* of the designed learning scenario, students have access to the web-based learning tool *Artist* (1). Figure 5 shows the user interface of the learning tool. Among other things, students can load predefined examples or generate their own texts. By clicking a button, the argumentative discourse structure of students' text is mined (using pre-trained classifiers) and the scores for the quality dimensions are calculated. Based on the results of the argument analysis process, the student receives visual feedback through a graphical representation of their arguments. In addition, students are provided with lecture slides (2) depicting key argumentation concepts similar to the one in Figure 3.

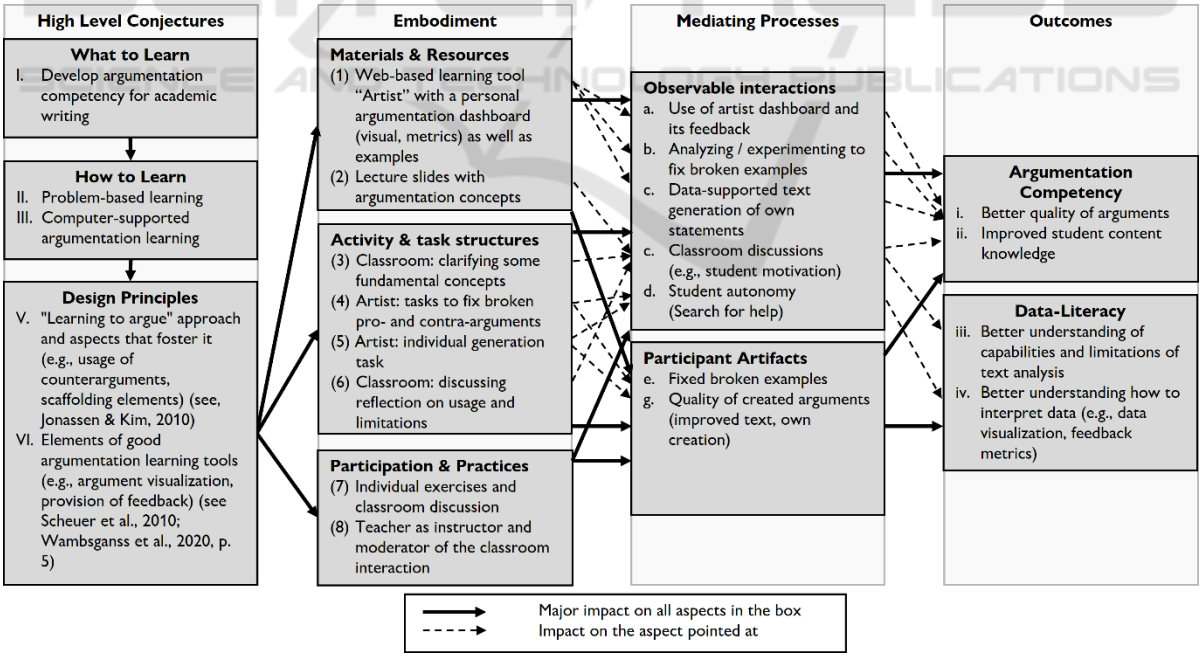

Figure 4: Conjecture map of the designed learning scenario.

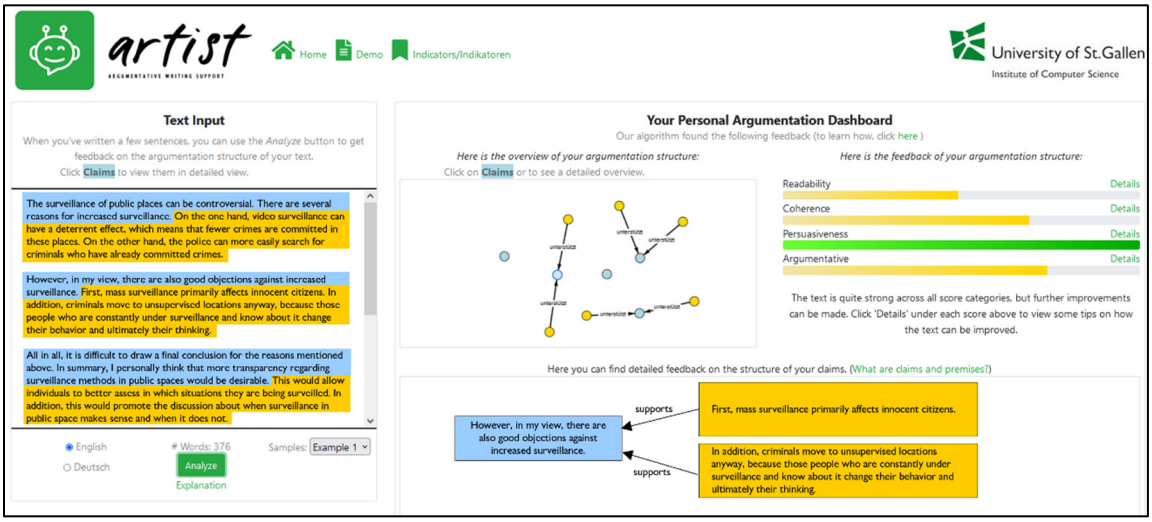

Figure 5: User interface of the learning tool *Artist*.

Note: The tool *Artist* is an adapted version based on the tool *Argumentation Learning* developed at the University of St.Gallen by Wambsganss et al. (2020). The tool *Artist* was tested with German-speaking students in the German language. For the purpose of illustration, Figure 5 is displayed in English.

Based on the provided lecture slides (2), the teacher in a first step clarifies fundamental concepts (3) such as the distinction between claims and premises or the use of indicators to construct arguments (e.g., through words like "because", "therefore" etc.). We consider this step important to bring everyone on the same level and to avoid conceptual misunderstandings. After that, students are advised to use *Artist*. In the sense of a *problem-based* learning approach (II), the students are confronted with multiple broken examples that are not working properly inside the *Artist* tool (4). Students are given the task of correcting and improving the incorrect examples by analyzing the examples with the tool and adjusting them as they see fit. While correcting the flawed examples, students are required to back up both *arguments* as well as *counterarguments* on the same topic in order to adopt a less self-centred and more holistic perspective. Figure 6 shows such a broken example (left side of Figure 6), that had to be fixed (right side of Figure 6).

After students have become familiar with the *Artist* tool by solving multiple predefined examples on a given topic (4), the students are given the task of creating their own conclusion on the topic and justifying it (5). After that, a classroom discussion between the teacher and the students takes place, where the experiences made with *Artist* are critically reflected and limitations pointed out (6). Overall, the *embodiment* (see Figure 4) can be characterized by a mixture of individual exercises with *Artist* as well as classroom discussions (7), in which the teacher takes on the role of an instructor and moderator of classroom interaction (8).

4.3 Mediating Processes

As *mediating processes* (see Figure 4), we can observe the students' use of the *Artist* dashboard (a.), how they experiment with strategies to fix the broken examples (b. & e.) as well as the generation of their own texts inside the *Artist* tool (c.) to improve their text quality (g.). In addition, the teacher can observe student motivation (c.) (e.g., during classroom discussions) as well as student autonomy (d.) (e.g., measured by how many times students need assistance while working with *Artist*).

4.4 Outcomes

Regarding the *outcomes* (see Figure 4), on the one hand, we expect that students have improved *argumentation competency*. Because students are guided in their argument creation by the *Artist* tool, we expect them to create arguments with better quality (i.). In addition, as during the classroom discussions experiences made with the tool are critically reflected and argumentative concepts investigated, we expect that students will have an improved content knowledge about argumentation (ii.). On the other hand, students may also have *improved data-literacy* due to the participation in the

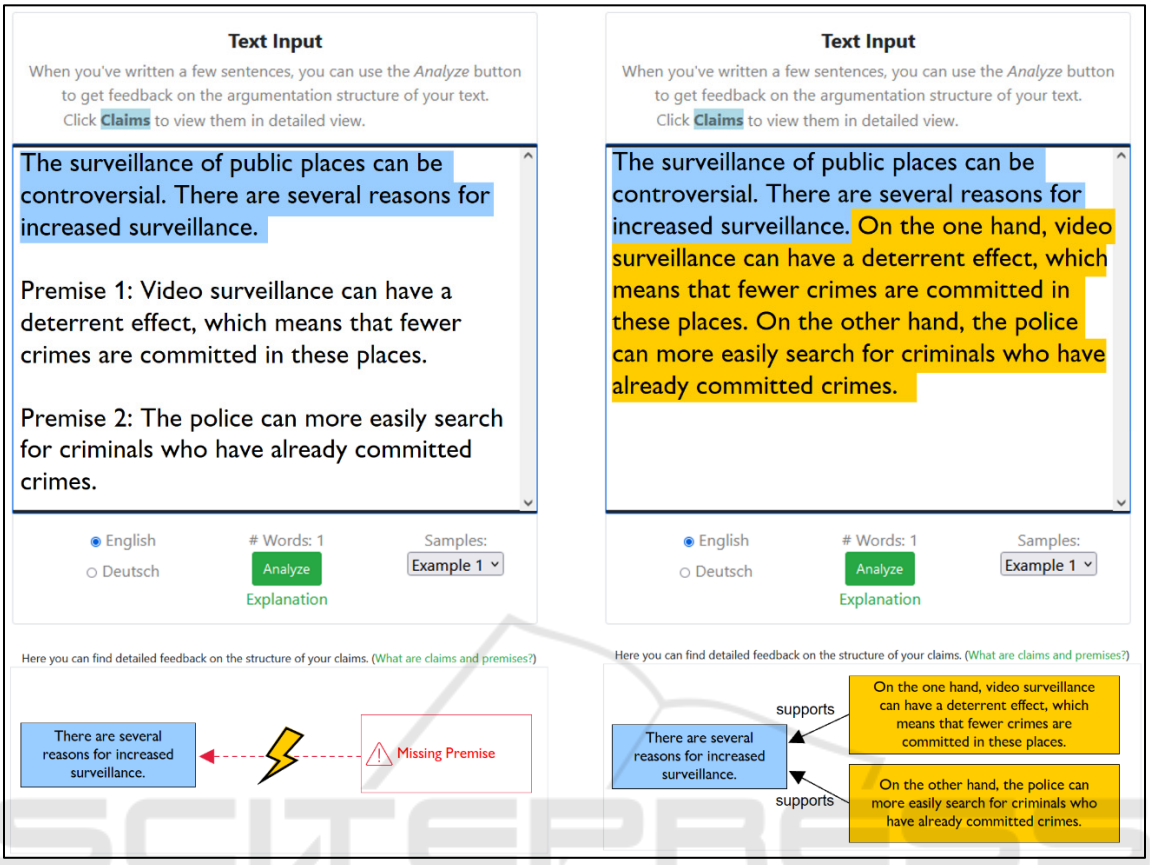

Figure 6: Problem-based learning environment: fixing broken examples.

Note: The tool *Artist* was tested with German-speaking students in the German language. For the purpose of illustration, Figure 6 is displayed in English.

learning scenario. By working with the tool as well as participating in the classroom discussions, students get a better understanding of the capabilities and limitations of text analysis (iii.) and improve their understanding on how to interpret data (iv.) (e.g., understanding data visualization and feedback metrics in general, applying them to their own text).

5 EVALUATION & REFLECTION

As part of an initial EDR design cycle, the learning design described in the previous section was tested in the fall term of 2022 at the University of St. Gallen with seven academic writing classes. The learning design was tested with German-speaking students in the German language. Since a total of 80 students participated in the learning design, this corresponds to a class size of 10-15 students per class.

In a *first phase*, the teacher clarified fundamental argumentation concepts. For this purpose, lecture slides were used. Students learned about the difference between claims and premises as well as indicators (e.g., “because”, “as a result”) to construct arguments. Since students in the first semester are very heterogeneous in terms of their prior knowledge, this approach seemed meaningful to establish a common ground (e.g., regarding the terminology used to describe arguments). During this phase of around five to ten minutes, students seemed motivated and had only few comprehension questions.

In a *second phase*, the teacher shared the link to *Artist*. The students were given the task to solve within *Artist* the predefined examples about the topic of “public surveillance”. In the process, students had to correct and solve one example related to the pro-arguments and one example related to the contra arguments. After that, students were given the task by the teacher to generate with *Artist* their own conclusion about the topic and to justify it. During this phase of around ten minutes, the teacher walked around the classroom and observed the students'

behavior. Because all examples (as well as sample solutions if needed) were directly available in *Artist*, students could work independently and had only few, if any, questions.

In a *third phase*, students were asked to complete a short survey to stimulate reflection on the tool usage and to get formative feedback for future improvement of the *Artist* tool. In three open ended questions, students were asked 1) what they liked about the tool, 2) what features should be improved, and 3) to state reasons why they would or would not use the tool *Artist* as a support to write their own seminar paper.

Overall, the received feedback was mixed. 25 out of 80 students (31%) found the tool useful and would like to use it for writing their own seminar paper. These students thought the tool provided valuable feedback. 15 out of 80 students (19%) would not use the tool. These students mostly stated that they found the tool confusing in general, or that they were able to construct better arguments themselves in a more time efficient way without using the tool. 40 out of 80 students (50%) were still undecided and answered with maybe or probably. These students often thought that the tool could be valuable to get a second opinion, but that they sometimes had difficulties to understand why the tool made certain recommendations. Due to that fact, they found it difficult to fully rely on it.

After the survey, a classroom discussion took place, where the experiences made with *Artist* were critically reflected and limitations pointed out by the teacher. On the one hand, working with *Artist* can be valuable for first-year students, as it helps to understand the basic concepts of argumentation such as claims and premises. It also encourages thinking about meaningful text structure as well as the use of indicators to make an argument explicit. On the other hand, argumentation is often much more complex as it involves more than just claims and premises (see Toulmin's argument pattern in Figure 2). For example, arguments often involve further *backing (B)*, implicit motives underlying the premises and claims (Amhag, 2011, p. 4). Such implicit motives are often not mentioned, or one is not even explicitly aware of them. Particularly first-year students have trouble understanding their own positionality and thus their implicit assumptions about the world (Holmes, 2020). Writing *positionality statements* with students may be helpful to make implicit assumptions about the world explicit (Robinson & Wilson, 2022, pp. 10-16) to adopt a less self-centric, more holistic argumentation perspective. Such content is currently not included in *Artist*, but could be added to the learning environment in a next step.

As an additional limitation of the tool, the applied machine learning approach used by the tool to create the feedback recommendations was mentioned to the students. Since machine learning approaches today are often a black-box, it is difficult or even impossible to interpret why certain recommendations were made (Zornoza, 2020). Even though it is explained within *Artist* how the displayed metrics are (roughly) calculated and therefore attempted to create a certain transparency, not every recommendation made by the tool is comprehensible down to the last detail due to the applied machine learning approach. Therefore, students must critically question the recommendations they receive by the tool and strengthen in this way their *data-literacy competency*.

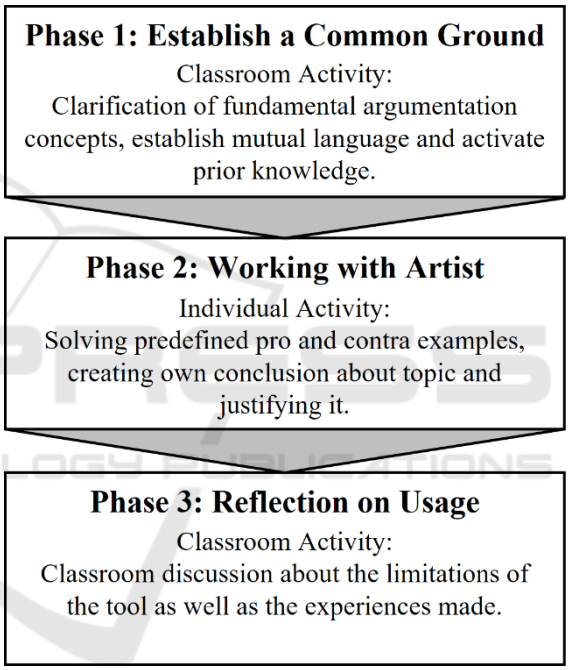

Figure 7: The three different phases of the learning scenario.

Overall, we believe that the testing of the learning design as part of a first EDR design cycle has been mostly successful. However, our designed learning scenario is subject to several limitations. *First*, the learning design (and its tool *Artist*) is still in a development phase and has therefore been tested with only seven classes whose teachers possessed a certain affinity for technology and were already familiar with the interface of the *Artist* tool. To test external validity, a larger sample size would be desirable. In handling *Artist*, additional new teachers may need to be instructed. *Second*, students only worked with *Artist* for a relatively short period of time of around ten to fifteen minutes because the tool was used in the

context of a normal classroom lesson to learn basic argumentation competency. In a next step, it would be interesting to investigate the use over a longer time period and with longer texts to see if *Artist* is not only helpful for learning basic argumentation competency but can support students also in their daily text writing (e.g., for writing a seminar paper). *Third*, no control group design was used, making it difficult to draw a definitive conclusion about the learning outcomes achieved. However, consistent with the EDR approach and the goal of obtaining formative feedback as part of an initial design cycle, this limitation was deliberately accepted.

In a next step, the goal will be to integrate more elements of the learning scenario into the *Artist* tool. For example, the clarification of fundamental argumentation concepts (3), undertaken by a teacher in our learning scenario, could be outsourced directly to *Artist* as part of an enhanced onboarding process. In the sense of a self-learning environment, this would allow students to work more independently with *Artist*.

5 CONCLUSION & OUTLOOK

This paper investigated how *learning designs with argumentation learning support systems* can be developed to increase argumentation competency of first-year university students. Building on literature about argumentation competency and how it can be fostered (see section 2), the conjecture mapping technique of Sandoval (2014) was used, to illustrate our assumptions as well as the expected conjectures. The designed learning scenario has the dual goal of fostering argumentation competency as well as data-literacy of students. Although the preliminary feedback received from the classes is promising, further iterative EDR cycles of development are needed to improve our learning design and to evaluate it for its learning effects.

From a theoretical perspective, the conjectures we have derived about the learning design can be a starting point for further research and discussion, as they highlight the complexity and multiple demands of technology applications in real classrooms (compared to a laboratory setting). From a practical perspective, the paper can serve as a guideline for other researchers who want to implement similar projects and explore the potential of the technology in more detail. It further contributes to a better understanding on how argumentation learning can be designed and implemented in the context of academic writing.

The designed learning scenario with *Artist* shows that writing tools can be used to support and relieve the teacher in the classroom. While using digital tools for education does not mean that fewer teachers are needed (Dillenbourg, 2016), the role of the teacher may evolve and change.

Although writing and argumentation tools can support us in our writing and even are able to create whole texts for us (such as chatGPT), argumentation competency will – in our view – remain of critical importance. Only if we understand what determines good arguments and can critically reflect on them, we will be able to make sense of the recommendations of such tools and adapt them to our needs. The GPT-3 language model (underlying model of ChatGPT) provides developers with a playground for prototypes to create training systems like *Artist*. However, once GPT-3 is used for an extended period of time, usage fees apply. The vision for the use of AI in academic writing could be to build an ecosystem of available tools for students and teachers in a digitally protected educational space. However, it is still an open question whether it makes sense to work with and build upon GPT-3 or to continue to use and develop smaller, open-source language models for this targeted purpose of argumentation.

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