Towards Designing an Adaptive Argumentation Learning Tool

Short Paper

Thiemo Wambsganss
University of St. Gallen
Müller-Friedberg-Str. 8, 9000
St.Gallen, Switzerland
thiemo.wambsganss@unisg.ch

Roman Rietsche
University of St. Gallen
Müller-Friedberg-Str. 8, 9000
St.Gallen, Switzerland
roman.rietsche@unsig.ch

Abstract

Digitalization triggers a shift in the compositions of skills and knowledge needed for students in their future work life. Hence, higher order thinking skills are becoming more important to solve future challenges. One subclass of these skills, which contributes significantly to communication, collaboration and problem-solving, is the skill of how to argue in a structured, reflective and well-formed way. However, educational organizations face difficulties in providing the boundary conditions necessary to develop this skill, due to increasing student numbers paired with financial constraints. In this short paper, we present the first steps of our design science research project on how to design an adaptive IT-tool that helps students develop their argumentation skill through formative feedback in large-scale lectures. Based on scientific learning theory and user interviews, we propose preliminary requirements and design principles for an adaptive argumentation learning tool. Furthermore, we present a first instantiation of those principles.

Keywords: *IT learning tool, argumentation learning, formative feedback, design science research*

Introduction

Nowadays, information is readily available so people need to develop skills other than reproduction of information. This manifests in a shift of job profiles towards interdisciplinary, ambiguous and creative tasks (vom Brocke et al. 2018). Therefore, educational institutions need to evolve in their curricula, especially regarding the compositions of skills and knowledge conveyed. Especially teaching higher order thinking skills to students, such as critical thinking, collaboration or problem-solving, have become more important (Fadel et al. 2015). This has already been recognized by the Organization for Economic Co-operation and Development (OECD), which included these skills as a major element of their Learning Framework 2030 (OECD 2018). One subclass represents the skill of arguing in a structured, reflective and well-formed way (Toulmin 1984). Argumentation is not only an essential part of our daily communication and thinking but also contributes significantly to the competencies of communication, collaboration and problem-solving (Kuhn 1992). Starting with studies from Aristoteles, the ability to form convincing arguments is recognized as the foundation for persuading an audience of novel ideas and plays a major role in strategic decision-making and analyzing different standpoints especially in regard to managing digitally enabled organizations.

To develop skills such as argumentation, it is of great importance for the individual student to receive continuous feedback throughout their learning journey, also called formative feedback (Black and Wiliam 2009; Hattie and Timperley 2007). However, educational organizations such as universities face the challenge of providing such learning conditions due to increasing numbers of students paired with financial resource constraints and thus more commonly large-scale lectures. The numbers provided by the OECD mirror this development. According to these figures, the number of students at universities increased, for example, by 15 percentage points in the US and by 29 in Germany, while public spending for education decreased by 7 percentage points in the US and 1 in Germany between 2005 and 2014 (OECD 2016). Keeping these organizational and economic boundaries in mind, the effective use of IT seems to be a promising approach to improve the teaching of argumentation skills in large-scale scenarios individually, for example, through intelligent tutoring systems (ITS). A solution might be the usage of an adaptive technology-based application in a student's learning journey. Researchers, especially from the fields of educational technology, have designed tools to support the active teaching of argumentation for students with input masks or representational guidelines to enhance students' learning of argumentation (e.g., De Groot et al. 2007; Osborne et al. 2016; Pinkwart et al. 2009). However, current literature falls short of providing an approach with principles and proof on how to design an adaptive and intelligent IT-tool to help students learn how to argue with intelligent formative feedback. Therefore, we aim to contribute to the field of argumentation learning by answering the following research question:

RQ*: What are the design principles for an IT-tool that helps students improve their argumentation skill in large-scale lectures?*

To answer the stated research question, we follow the design science research approach (DSR) by Hevner 2007. As stated above, there is a lack of design knowledge for IT-tools to convey argumentation skills. The DSR approach is particularly suited to address such research gaps. We intend to iteratively design and evaluate a simple IT-learning artifact on the baseline of existing theory (cognitive dissonance based on Festinger 1962) informing the artifact design (Hevner et al. 2004). We believe cognitive dissonance theory could explain why formative feedback on a student's argumentation will motivate the student to learn how to argue. To the best of our knowledge, there is no study that rigorously derives requirements from both scientific literature and potential users to develop an adaptive IT learning tool for helping students learn how to argue based on this theory. With adaptive learning tool, we implicate a tool which provides individual and real-time feedback to students on a given text. In this short paper, we aim to present the preliminary results of our first four steps. In the following, we will first introduce the reader to the necessary theoretical background. Afterwards, we present our methodological approach for developing the artefact following the three cycle-view of Hevner 2007. Finally, our preliminary results of the first four steps are presented, followed by an outline of the subsequent steps and the expected implications once our research is completed.

Theoretical Background

Argumentation Learning

Argumentation is an omnipresent foundation of our daily communication and thinking. In general, it aims at increasing or decreasing the acceptability of a controversial standpoint (Eemeren et al. 1996). Logical, structured arguments are a required precondition for persuasive conversations, general decision-making and drawing acknowledged conclusions. In the context of digitalization, the ability to argue becomes increasingly important for successful collaboration in almost every job, since job profiles are shifting towards interdisciplinary, ambiguous and creative tasks (vom Brocke et al. 2018). This has been recognized by the OECD, which named these meta cognition skills a major part of their Learning Framework 2030 (OECD 2018). Not only in industry but also in research, studies show that argumentation is central to scientific thinking (Duschl and Osborne 2002; Kuhn 1993). As von Aufschnaiter *et al.*, 2008 describes, scientists engage in argumentation to articulate, refine and discuss their scientific statements and the ones of others. As Kuhn (1992) states, the skill to argue is of great significance not only for professional purposes like communication, collaboration and for solving difficult problems but also for most of our daily life: *"It is in argument that we are likely to find the most significant way in which higher order thinking and reasoning figure in the lives of most people. Thinking as argument is implicated in all of the beliefs people hold, the judgments they make, and the conclusions they come to; it arises every time a significant decision must be made. Hence, argumentative thinking lies at the heart of what we should be concerned about in examining how, and how well, people think*" (Kuhn 1992, pp. 156–157).

However, teaching argumentation is limited. Jonassen and Kim, 2010 identified three major causes for that: "*teachers lack the pedagogical skills to foster argumentation in the classroom, so there exists a lack of opportunities to practice argumentation; external pressures to cover material leaving no time for skill* *development; and deficient prior knowledge on the part of learners"*. Therefore, many authors have claimed that fostering argumentation skills should be assigned a more central role in our formal educational system (Driver et al. 2000; Kuhn 2005). Most students learn to argue in the course of their studies simply through interactions with their classmates or teachers. In fact, individual support of argumentation learning is missing in most learning scenarios. However, to train skills such as argumentation, it is of great importance for the individual student to receive continuous feedback, also called formative feedback, throughout their learning journey, (Hattie and Timperley 2007). According to Sadler 1989, the outcome of feedback is a specific information relating to the task or process of learning that fills a gap between what is understood and what is aimed to be understood. Even in fields where argumentation is part of the curriculum, such as law and logic, a teacher's ability to provide feedback is naturally limited by constraints on time and availability (Scheuer 2015). Especially in more common large-scale lectures, the ability to support a student's argumentation skills individually is hindered, since for teachers and professors, it is becoming increasingly difficult to provide ongoing and individual feedback to a single student.

Technology-Based Learning Systems for Argumentation

The application of information technology in education bears several advantages, that is, consistency, scalability, perceived fairness, widespread use, better availability compared to human teachers, etc., and thus IT-based argumentation systems can help to relieve some of the burden on teachers to teach argumentation by supporting learners in creating, editing, interpreting or reviewing arguments (Scheuer et al. 2010). Koschmann, 1996 distinguished between four main paradigms in the field of educational technology. Each paradigm holds specific assumptions about learning and teaching and utilizes specific technological and research approaches. They distinguished between computer-assisted instruction (CAI), intelligent tutoring systems (ITS), Logo-as-Latin, and computer-supported collaborative learning (CSCL) (Koschmann 1996). The two paradigms CSCL and ITS are of special relevance for argumentation learning (Scheuer 2015), since argumentative discussions and debates have been identified as a key for collaborative learning settings. Therefore, argumentation emerged as a focus area in CSCL. ITS is more centered around analyzing, modeling, and supporting IT-based learning activities in specific domains. A relatively new research area is the combination of both CSCL and ITS to support collaboration and argumentation in an adaptive and individual way (Fischer et al. 2013). Researchers have designed and evaluated several tools based on input masks and representational guidelines to support the active writing process of high school students. This has been investigated across a variety of fields, including law (Pinkwart et al. 2009), science (Osborne et al. 2016; Suthers and Hundhausen 2001) and conversational argumentation (De Groot et al. 2007).

The design and implementation of ITS and CSCL is, however, a complex endeavor that must rely on expertise from the fields of computer science (i.e., development of the algorithms), human-computer interaction (i.e., design of the interface) and pedagogics (i.e., integration into the learning process). Adaptive support approaches for argumentation learning (e.g., Pinkwart *et al.*, 2009; Stab and Gurevych, 2014, 2017; Huang *et al.*, 2016) describe a rather new field of argumentation learning supported by IT-based systems. The aim is to provide pedagogical feedback on a learner's action and solutions, hints and recommendations to encourage and guide future activities in the writing processes or automated evaluation to indicate whether an argument is syntactically and semantically correct. However, the combination of text mining, intelligent tutoring systems and pedagogically evaluated formative feedback in a student's learner journey is merely investigated due to high complexity. As Scheuer 2015 identifies, *"rigorous empirical research with respect to adaptation strategies is almost absent; a broad and solid theoretical underpinning, or theory of adaptation for collaborative and argumentative learning is still lacking"*. Therefore, we aim to address this research gap and rigorously design an argumentation learning tool based on educational theory by the application of recent developments in natural language processing and machine learning, in which argumentation mining has been a proven approach to identify and analyze argumentative structures of a given text in real-time (Lippi and Torroni 2015). Argumentation Mining is about the identification and classification of argumentation. The potential of AM has been investigated in different research domains, however, not leverage for individual feedback in a student's learning progress (Lippi and Torroni 2015).

Cognitive Dissonance as a Kernel Theory

We built our research endeavor on cognitive dissonance theory. We believe that this theory supports our underlying hypothesis that individual and personal feedback on a student's argumentation motivates the student to improve her skill level. Cognitive dissonance refers to the uncomfortable feeling that occurs when there is a conflict between one's existing knowledge or beliefs and contradicting presented information (Festinger 1962). This unsatisfying internal state results in a high motivation to solve this inconsistency. According to Festinger's theory, an individual experiencing this dissonance has three possible ways to resolve it: change the behavior, change the belief or rationalize the behavior. Especially for students in a learning process, dissonance is a highly motivating factor to gain and acquire knowledge to actively resolve the dissonance (Elliot and Devine 1994). It can be an initial trigger for a student's learning process and thus the construing of new knowledge structures (Piaget et al. 1986). However, the right portion of cognitive dissonance is very important for the motivation to solve it. According to Festinger, individuals might not be motivated enough to resolve it if the dissonance is too obvious, whereas a high level of dissonance might lead to frustration. Therefore, we believe that the right level of feedback on a student skill, such as argumentation skills, could lead to cognitive dissonance and thus to motivation to change the behavior, belief or knowledge to learn how to argue.

Research Methodology

Our study is guided by the DSR approach (Hevner 2007). We decided to follow this approach to use a scientific method in order to solve a set of practical problems that researchers and practitioners experience in their own practice and to contribute to the existing body of knowledge by designing and evaluating a new research artifact. Figure 1 shows the steps that are being carried out. In this research-in-progress paper, we report on the preliminary findings of the first four steps (see highlighted circles). Overall, our research project aims to contribute to research with a nascent design theory that gives explicit prescriptions for designing this class of artifacts (Gregor and Hevner 2013). We followed a theory-driven design approach by grounding our research on the theory of cognitive dissonance (Festinger 1962).

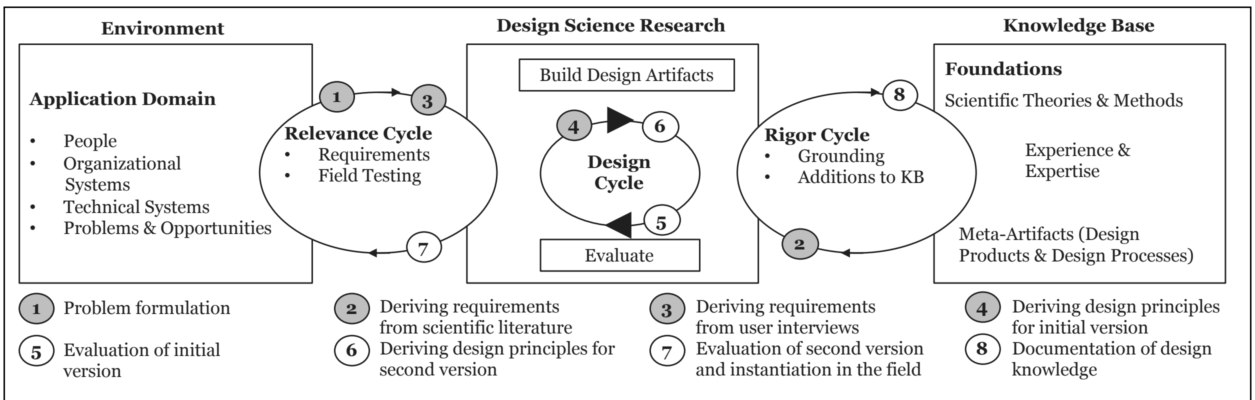

Figure 1. Three cycle design science process according to Hevner (2007)

The first step of the DSR cycle includes the problem formulation. The relevance of the practical problem was therefore described in the introduction of this work. In the second step, we derived a set of meta-requirements (MRs) from the current state of scientific literature for the design of an argumentation learning tool. Next, we conducted nine semi-structured interviews with master students, using the expert interview method by Gläser and Laudel (2010). Based on the interviews, we gathered user-stories (USs) and user requirements (URs) for the design of our argumentation learning tool. In the fourth step, we derived preliminary design principles (DPs) addressing the MRs and URs from the prior steps, using the structure suggested by Chandra et al. 2015, and designed an initial version as a first instantiation of these DPs. In our future research, we aim to evaluate this initial version based on the evaluation framework proposed by (Venable et al. 2016). They suggest four evaluation strategies, from which we aim to use the human risk and effectiveness strategy, since our research aims to focus on a user-centered artefact that needs to prove its utility and benefit in a real-world context (e.g., application in a large-scale lecture). Thus, we will first evaluate our prototype in a formative and artificial setting (i.e., lab experiment) to evaluate if all design principles are fulfilled. In this experiment, students will use the developed prototype by writing an argumentative text for a computer-based exercise, on which they receive an instant feedback on their argumentation. Subsequently, user perceptions will be captured with a questionnaire. Then, we will refine our design principles based on the findings from this evaluation before designing a second version, which can then be tested in a larger evaluation in a natural setting in a large-scale lecture. We aim to use methods from natural language processing and machine learning (e.g., Argumentation Mining) to give instant and individual feedback to students. Following the design by Bauman and Tuzhilin 2018, we plan to conduct a field experiment with three groups to evaluate the impact of the adaptive feedback (provided by our feedback algorithm based on Argumentation Mining) on the development of students' argumentation quality. We will rely on one control group (participants will not receive any feedback) and two treatment groups. Participants in treatment group 1 will receive information on how their argumentation quality was scored and general feedback on how to improve it, whereas participants in treatment group 2 will receive information on how their argumentation quality was scored, as well as individualized feedback based on their own performance on how they could improve their argumentation quality. The functionalities necessary for the treatments will be implemented into our existing learning system (Rietsche et al. 2018). At the end of the study, we want to contribute with a evaluated learning tool which can be used in a learning-teaching scenario where students fulfill a certain exercise in a lecture (e.g., writing a convincing statements on a business model) and additionally receive feedback on their argumentation on the given text. The findings from the evaluation will be summarized as a nascent design theory (Gregor and Hevner 2013) for IT learning tools to support higher order thinking skills.

Designing the Artefact

In this section, we will describe and discuss how we gathered the preliminary requirements and derived the preliminary DPs. The problem formulation (step one), described in the introduction, serves as the foundation for the derivation of the requirements from literature and users. The main insights are illustrated in Figure 2.

Rigor: Deriving Meta-Requirements from Scientific Literature

To derive requirements from scientific literature, a systematic literature search was conducted using the methodological approaches of Cooper 1988 and vom Brocke et al. 2015. We initially focused our research on studies that demonstrate the successful implementation of learning tools for argumentation skills. Two broad areas for deriving requirements were identified: Educational technology and learning theories. Since the creation of a learning tool for argumentation skills is a complex project that is studied by psychologists, pedagogues and computer scientists with different methods, we first concentrated on these literature streams. We only included literature that deals with or contributes to a kind of learning tool in the field of argumentation learning, such as an established learning theory. On this basis, we selected 67 papers for more intensive analysis. We have summarized similar topics of these contributions as literature issues (LIs) and formed four clusters from them. Based on these LIs, we derived MRs for the design of the IT-tool. In the theory of learner-centered design (**LI1**), Soloway et al. 1994 named the concept of scaffolds as a central component of learning software when the task is to complete constructive activities such as writing argumentative texts. Accordingly, the IT-tool should comprise a specific goal, purpose and orientation to help learners reflect on what they are learning and give guidance on the context and their tasks (Soloway et al. 1994) (**MR1**). Hattie and Timperley 2007 named feedback as a key ingredient for learning in higher education (**LI2**). Individual formative feedback is essential for the learning of higher order thinking, and thus for argumentation skills. Effective Feedback should answer three goals: "Where am I going, how am I going, where to go next"; hence, the requirement is defining goals, monitoring progress towards the goals and naming activities to reach the goals (**MR2**). Furthermore, based on cognitive load theory (Sweller 1994), Mayer and Moreno 2003 defined an e-learning theory with a set of principles on how educational technology can be used and designed to promote effective learning. Besides different principles which we incorporated in our design of the initial prototype, the learners' control principle **(LI3)** is of special significance for learning meta cognition skills, since it aims to enable learners to adjust the amount of input information needed for their personal learning process (**MR3**). Moreover, in his cognitive theory of multimedia learning, Mayer 2009 named the "multimedia principles" (**LI4**), which states that "*people learn more deeply from words and pictures than from words alone*" (p.47, Mayer 2009). He assumes that a learner has two separate channels (auditory and visual) for processing information, each channel has limited capacity and learning is an active process of filtering information based on prior knowledge. Therefore, to guide learners, the IT-tool needs to incorporate both words and images to reduce the load for a single processing channel (**MR4**).

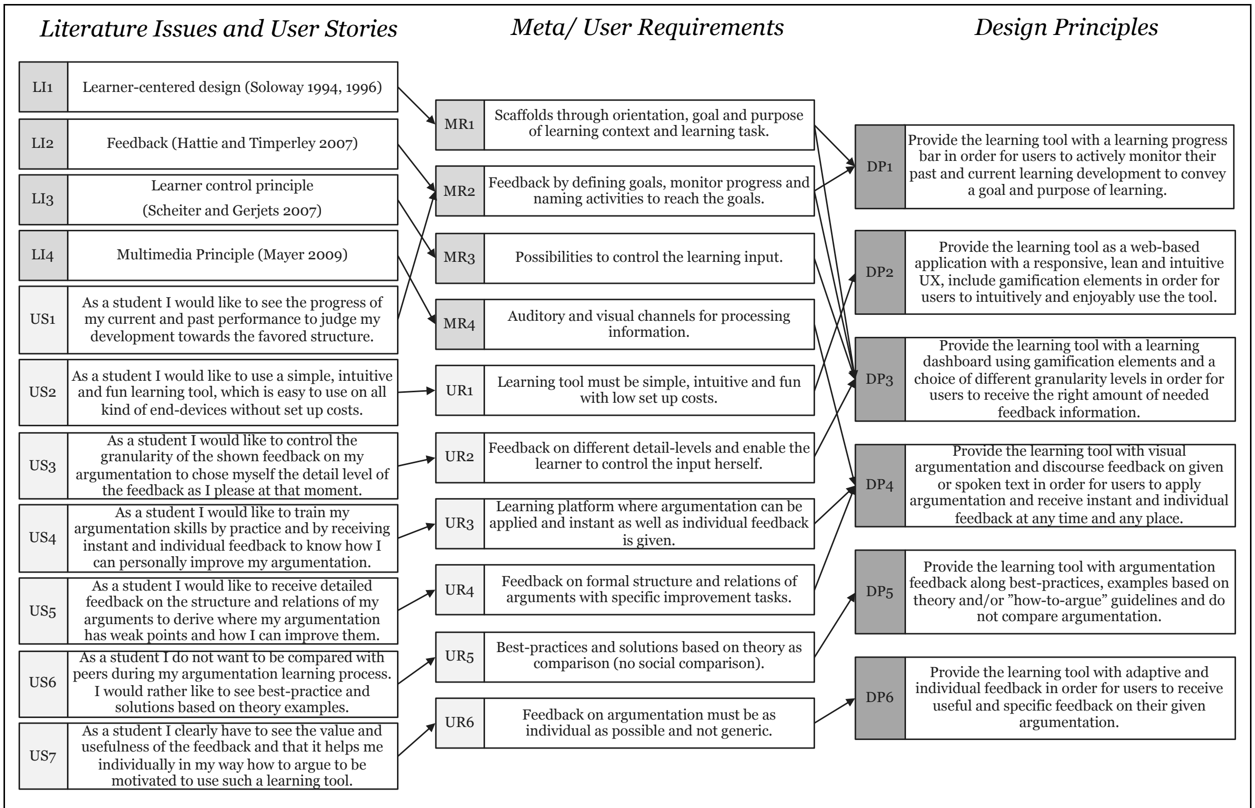

Figure 2. Overview of the derived design principles according to Chandra et al. (2015)

Relevance: Deriving Requirements from Expert Interviews

Based on the derived LIs and MRs, we conducted nine semi-structured interviews according to Gläser and Laudel (2010). The interview guideline consists of 29 questions and each interview lasted around 40 to 50 minutes. The interviewees were a random subset of the population of students at our university who are all potential users of our argumentation learning tool. The participants were asked about the following topics: experience with technology-based learning systems, perception of existing learning systems in use, importance of skills in university education, requirements for a system that supports learning meta cognition skills (e.g. functionalities, design), requirements for a system that supports learning how to argue (e.g. functionalities, design). In order to gain impressions resulting from many years of learning experience, only Master students were recruited for the interviews. The interviewed students were between 23 and 28 years old and all students of economics, six were male, three female. After a more precise transcription, the interviews were evaluated using a qualitative content analysis. The interviews were coded, and abstract categories were formed. The coding was performed using open coding to form a uniform coding system during evaluation (Gläser and Laudel 2010). Based on these results, we gathered user-stories (USs) and identified user requirements (URs) following Cohn 2004. A major need of students was to monitor the progress of the current and past performance to judge the development towards the favored structure, and consequently the learning goal (**US1**), which we reflected in **MR2**. All students mentioned that the learning tool must be simple, intuitive, fun in the user experience (UX) and easy to set up on any device (**US2**), which we incorporated in **UR1**. Moreover, all students mentioned that they would like to control the granularity of the shown feedback on their argumentation skills (**US3**). On top of that, a majority clearly mentioned that they would like to receive an overview of different feedback categories, for example, formal and discourse structure, strength and weaknesses, and additionally, the possibility to zoom in on those categories to gain detailed feedback (**UR2**). Furthermore, instant individual feedback based on written or spoken text is needed (**US4**). Hence, the learning tool should provide an application field of inserting argumentative input and provide instant and individual feedback (**UR3**). The content and the representation of the argumentation feedback was mentioned multiple times in the interviews. Detailed feedback on the formal structure and relations of their arguments is needed to derive vulnerability of argumentation and thus specific recommendations on how to improve (**US5**). Subsequently, we derived the requirement to provide feedback on formal structures and relations of arguments with specific improvement tasks (**UR4**). Next**,** 80% of the students claimed a social comparison with peers during their argumentation learning process would hinder their learning. In fact, they stated that a comparison with theoretical models (e.g., Toulmin 2003) or best-practices on how to improve would be more beneficial in their learning process (**US6**). Thus, best-practices and solutions based on theory comparison should be included in the argumentation learning tool (**UR5**). To use the tool continuously, all students mentioned that the value and usefulness of the provided feedback has to be individual and specific (**US7**). An evaluation that is too generic and possible recommendations without individual impact would be a reason to not use the tool again (**UR6**).

Figure 3. Argumentation learning tool based on the developed design principles

As illustrated, we have identified four LIs, seven USs and formulated four preliminary MRs and six preliminary URs. Based on those findings, we derived six preliminary DPs for a learning tool for argumentation skills as a special class of learning tools for meta cognition skills. The design principles are depicted in Figure 2. We believe they are self-explanatory; however, we will discuss them further in our next publication. Our DPs were formulated based on the analysis of current issues related to theory of learning and teaching higher order thinking skills and needs and requirements of users based on cognitive dissonance theory (Festinger 1962). We argue that a learning tool for argumentation skills (and possibly also meta cognition skills) that instantiates our DPs should increase the motivation of students to learn how to apply the certain skills, for example, learn how to argue, and thus improve the learning outcome. For example, an argumentation learning tool that provides instant and individual feedback and gives students the flexibility to control their learning input and monitor their learning progress should increase the students' motivation to resolve dissonance and therefore construct new knowledge. To provide an instantiation example of our design principles, we designed an initial version to give guidance and illustration for scientists and practitioners. Figure 3 shows the prototype and how the different DPs are aimed to be fulfilled.

Conclusion and Expected Contributions

In this paper, we provide the first steps of designing an IT-tool to help students learn how to argue. The training of this skill is especially important because it contributes significantly to communication, collaboration and problem-solving, which are higher order thinking skills that become more import to solve future challenges. However, educational organizations face difficulties in providing the boundary conditions necessary to develop this skill, due to increasing student numbers paired with financial constraints. Hence, we discussed four literature issues and seven user stories on how to design an argumentation learning tool and presented four preliminary MRs and six URs from nine interviews as well as six DPs that address them. We presented an initial version as an instantiation of these design principles. Next, we will evaluate this version in a formative and artificial setting (Venable et al. 2016), revise the design principles and analyze the impact of the instantiated learning tool on students' learning performance in a large-scale lecture experiment. We aim to use methods from natural language processing and machine learning (e.g., argumentation mining) to give instant and individual feedback to students. We expect our overall research project to contribute with a nascent design theory (Gregor and Hevner 2013) to the artefact class of IT learning tools for meta cognition skills. In terms of DSR, our research can be classified as an improvement, according to the DSR contribution framework by Gregor and Hevner 2013, since we address a known problem with a new solution.

References

von Aufschnaiter, C., Erduran, S., Osborne, J., and Simon, S. 2008. "Arguing to Learn and Learning to Argue: Case Studies of How Students' Argumentation Relates to Their Scientific Knowledge," *Journal of Research in Science Teaching* (45:1), pp. 101–131.

Bauman, K., and Tuzhilin, A. 2018. "Recommending Remedial Learning Materials to Students by Filling Their Knowledge Gaps," *MIS Quarterly* (42:1), pp. 313–332.

Black, P., and Wiliam, D. 2009. "Developing the Theory of Formative Assessment," *Educational Assessment, Evaluation and Accountability* (21:1), pp. 5–31.

vom Brocke, J., Maaß, W., Buxmann, P., Maedche, A., Leimeister, J. M., and Pecht, G. 2018. "Future Work and Enterprise Systems," *Business and Information Systems Engineering* (60:4), pp. 357–366.

vom Brocke, J., Simons, A., Riemer, K., Niehaves, B., Plattfaut, R., and Cleven, A. 2015. "Standing on the Shoulders of Giants: Challenges and Recommendations of Literature Search in Information Systems Research," *Communications of the Association for Information Systems* (37:1).

Chandra, L., Seidel, S., and Gregor, S. 2015. "Prescriptive Knowledge in IS Research: Conceptualizing Design Principles in Terms of Materiality, Action, and Boundary Conditions," *HICSS*, pp. 4039–4048.

Cohn, M. 2004. "User Stories Applied For Agile Software Development."

Cooper, H. M. 1988. "Organizing Knowledge Syntheses: A Taxonomy of Literature Reviews," *Knowledge in Society* (1:1), pp. 104–126.

Driver, R., Newton, P., and Osborne, J. 2000. "Establishing the Norms of Scientific Argumentation in Classrooms," *Science Education* (84:3), John Wiley & Sons, Ltd, pp. 287–312.

Duschl, R. A., and Osborne, J. 2002. "Supporting and Promoting Argumentation Discourse in Science Education," *Studies in Science Education* (38:1), pp. 39–72.

Eemeren, F. H. van, Grootendorst, R., Johnson, R. H., Plantin, C., Willard, C. A., Grootendorst, R., Johnson, R. H., Plantin, C., and Willard, C. A. 1996. *Fundamentals of Argumentation Theory*, Routledge.

Elliot, A. J., and Devine, P. G. 1994. "On the Motivational Nature of Cognitive Dissonance: Dissonance as Psychological Discomfort.," *Journal of Personality and Social Psychology* (67:3), pp. 382–394.

Fadel, C., Bialik, M., and Trilling, B. 2015. *Four-Dimensional Education : The Competencies Learners Need to Succeed.*

Festinger, L. 1962. "Cognitive Dissonance," *Scientific American* (207:4), pp. 93–106.

Fischer, F., Kollar, I., Stegmann, K., and Wecker, C. 2013. "Toward a Script Theory of Guidance in Computer-Supported Collaborative Learning.," *Educational Psychologist* (48:1), Taylor & Francis, pp. 56–66.

Gläser, J., and Laudel, G. 2010. *Experteninterviews Und Qualitative Inhaltsanalyse : Als Instrumente Rekonstruierender Untersuchungen*, VS Verlag für Sozialwiss.

Gregor, S., and Hevner, A. R. 2013. "Positioning and presenting design science research for maximum impact," *MIS quarterly* (37:2), pp. 337–355.

De Groot, R., Drachman, R., Hever, R., Schwartz, B., Hoppe, U., Harrer, A., De Laat, M., Wegerif, R., Mclaren, B. M., and Baurens, B. 2007. "Computer Supported Moderation of E-Discussions: The ARGUNAUT Approach."

Hattie, J., and Timperley, H. 2007. *The Power of Feedback The Meaning of Feedback*, (77:1), pp. 81–112.

Hevner, A. R. 2007. "A Three Cycle View of Design Science Research," *Scandinavian Journal of Information Systems*, INFORMATION SYSTEMS GROUP, UNIVERSITY OF AALBORG, pp. 1–6.

Hevner, A. R., March, S. T., Park, J., and Ram, S. 2004. "Design Science in Information Systems Research," *Design Science in IS Research MIS Quarterly* (28:1), p. 75.

Huang, C. J., Chang, S. C., Chen, H. M., Tseng, J. H., and Chien, S. Y. 2016. "A Group Intelligence-Based Asynchronous Argumentation Learning-Assistance Platform," *Interactive Learning Environments* (24:7), pp. 1408–1427.

Jonassen, D. H., and Kim, B. 2010. "Arguing to Learn and Learning to Argue: Design Justifications and Guidelines," *Educational Technology Research and Development* (58:4), pp. 439–457.

Koschmann, T. 1996. "Paradigm Shifts and Instructional Technology," Lawrence Erlbaum Associates.

Kuhn, D. 1992. "Thinking as Argument," *Harvard Educational Review* (62:2), pp. 155–179.

Kuhn, D. 1993. "Science as Argument: Implications for Teaching and Learning Scientific Thinking," *Science Education* (77:3), John Wiley & Sons, Ltd, pp. 319–337.

Kuhn, D. 2005. *Education for Thinking*, Harvard University Press.

Lippi, M., and Torroni, P. 2015. "Argumentation Mining: State of the Art and Emerging Trends," *IJCAI International Joint Conference on Artificial Intelligence*, pp. 4207–4211.

Mayer, R. E. 2009. *Multimedia Learning*, Cambridge: Cambridge University Press.

Mayer, R. E., and Moreno, R. 2003. *Nine Ways to Reduce Cognitive Load in Multimedia Learning*.

OECD. 2018. *The Future of Education and Skills - Education 2030*.

Osborne, J. F., Henderson, J. B., MacPherson, A., Szu, E., Wild, A., and Yao, S. Y. 2016. "The Development and Validation of a Learning Progression for Argumentation in Science," *Journal of Research in Science Teaching* (53:6), pp. 821–846.

Piaget, J., Brown, T., and Thampy, K. J. 1986. "The Equilibration of Cognitive Structures: The Central Problem of Intellectual Development. Jean Piaget , Terrance Brown , Kishore Julian Thampy," *American Journal of Education* (94:4), pp. 574–577.

Pinkwart, N., Ashley, K., Lynch, C., and Aleven, V. 2009. "Evaluating an Intelligent Tutoring System for Making Legal Arguments with Hypotheticals," *Int. Journal of Artificial Intelligence in Education*.

Rietsche, R., Duss, K., Persch, J. M., and Soellner, M. 2018. "Design and Evaluation of an IT-based Formative Feedback Tool to Forster Student Performance," *Proceedings of the International Conference on Information Systems (ICIS) 2018*, San Francisco, California, USA.

Sadler, D. R. 1989. "Formative Assessment and the Design of Instructional Systems," Instructional Science (18:2), pp. 119–144.

Scheuer, O. 2015. Towards Adaptive Argumentation Learning Systems.

Scheuer, O., Loll, F., Pinkwart, N., and McLaren, B. M. 2010. "Computer-Supported Argumentation: A Review of the State of the Art," *Int. Journal of Comp-Sup. Collaborative Learning* (5:1), pp. 43–102.

Soloway, E., Guzdial, M., and Hay, K. E. 1994. "Learner-Centered Design: The Challenge for HCI in the 21st Century," *Interactions* (1:2), ACM, pp. 36–48.

Stab, C., and Gurevych, I. 2014. "Identifying Argumentative Discourse Structures in Persuasive Essays," in *EMNLP, Association for Computational Linguistics*, pp. 46–56.

Stab, C., and Gurevych, I. 2017. "Recognizing Insufficiently Supported Arguments in Argumentative Essays," *The Association for Computational Linguistics* (Vol. 1).

Suthers, D. D., and Hundhausen, C. D. 2001. "European Perspectives on Computer-Supported Collaborative Learning."

Sweller, J. 1994. "Cognitive Load Theory, Learning Difficulty, and Instructional Design," *Learning and Instruction* (4:4), pp. 295–312.

Toulmin, S. E. 1984. *Introduction to Reasoning*.

Toulmin, S. E. 2003. *The Uses of Argument: Updated Edition*.

Venable, J., Pries-Heje, J., and Baskerville, R. 2016. "FEDS: A Framework for Evaluation in Design Science Research," *European Journal of Information Systems* (25:1), Nature Publishing Group, pp. 77–89.