

Critical design literacy through reflection in design

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This paper discusses a conceptual review of three frameworks for students' reflection in general design education. The frameworks were selected for their different focus of attention with respect to students' engagement with design products and environmental impacts. The review results indicated that the focus of attention affected the topics of reflection: the how-topics related to product design, the why-topics related to environmental impacts and the what-topics related to multiple solutions to challenges in both product design and environments. The paper discusses how researchers, teachers and students have different perspectives on whether the topics of reflection operate within established fields of practice or aim to transform them. The frameworks for reflection provide different contributions to enhance students' critical design literacy.

Keywords: critical design literacy; reflection; general design education

Critical design literacy

Critical design literacy is considered a key design competence for the development of sustainable societies and a potential learning outcome of design education. This competence encompasses aspects of both practice and reflection in design, and challenges design education to support students' development of their capacity to question, rethink and transform design practice.

The concept of critical design literacy draws on imbricated concepts and fields of research. *Design* relates to the making and understanding of products and systems (Nielsen, 2008a, p. 25), with the intended 'courses of action aimed at changing existing situations into preferred ones' (Simon, 1996, p. 111). *Literacy* refers to a competence for understanding and using knowledge in context (Ongstad, 2014; United Nations Educational, Scientific and Cultural Organization [UNESCO] 2004, 2005b). *Design literacy* is described as a competence to understand and create design of products in physical materials in a context supporting the development of sustainable environments (Nielsen & Brænne, 2013). This competence is also referred to as *design literacy for sustainability* (Maus, 2019a, 2019b, 2020), in reference to the aims of developing sustainability in ecological, social and economic environments across generations (World Commission on Environment and Development [WCED], 1987). Also, closely related and embedded in design literacy is research on the use of ecological literacy in design, concerning ecological systems and how products and production process interfere with these (Boehnert, 2015; Lutnæs & Fallingen, 2017; Stegall, 2006). The *critical* aspect of design literacy is described in research on *critical innovation* (Lutnæs, 2019), and in associated research on the potential to enhance critical thinking and creativity for the development of sustainable societies (Lutnæs, 2015a, 2015b, 2017). Related research encompasses students' stances towards inquiry (Christensen, Hjorth, Iversen & Blikstein, 2016; Christensen, Hjorth, Iversen & Smith, 2018).

Critical design literacy is described as a competence for change in attitudes and actions, which empowers students to question established fields of practices. Aspects argued to be of importance to students' development of this competence are a reflection of challenges to be solved in the world *outside* the school studio, rather than only as a reflection on challenges to be solved in the process of making a product (Lutnæs, 2020). Moreover, critical reflection is performed on the *why* of action with the aim of transforming current knowledge and cultural practices rather than only on the *how* of action within an established field of practice (Lutnæs, 2021). This interpretation of the distinction between the roles of reflection on how and critical



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reflection on why in learning process is based on Mezirows's (1990) description of the fostering of critical reflection in adulthood. However, students develop their design literacy gradually through all levels of design education (European Design Leadership Board, 2012, pp. 67–71), and design literacy research encompasses general education (Nielsen & Digranes, 2012), professional design education (Pacione, 2010) and industrial design education (Clune, 2007). An application of this interpretation of critical reflection from adult education to educational practice for youth will require an examination of how topics of reflection can challenge perspectives on established practice among participants at a general level of education. The researchers, teachers and students will consider different practices as established, and therefore have different perspectives for their questioning of why and how they are used.

This paper consists of an inquiry into three frameworks for reflection in design education, which have different approaches to encouraging students to question, rethink and transform current design practice. The aim of this study is to show how the focus of attention on design products and environmental impacts can affect the how and why of action. Moreover, to discuss perspectives on how these frameworks support students to both operate within established fields of practices and to transform them. Thus, to discuss these frameworks' potentials for supporting students' development of their own critical design literacy.

Method of inquiry: A conceptual review of topics of reflection frameworks

The research presented in this paper was conducted through a conceptual review and analysis of the topics concerning the why and how of actions in design, which were embedded in three frameworks for students' reflections in general design education (Hofverberg & Maivorsdotter, 2018; Maus, 2019b; Lutnæs, 2017). The aim was to analyse how the topics of reflection about why and how in design practice are affected by the area of focus concerning the influence between students, design products and environmental impacts.

Furthermore, to discuss how the students, teachers and researchers have different perspectives about whether these topics operate within established fields of practice or aim to transform them. The study draws on, and is a further development of, the research presented in my article-based PhD thesis (Maus, 2020). The review design was inspired by Maxwell's (2006) description of literature reviews for research with relevance, creation of focus, conceptual framework, design and justification for the research, rather than reviews of a field of research. This can entail relevant theories, findings and methods from other fields or disciplines. In this study, I analyse and discuss frameworks located through review of research conducted with different intentions and methods.

The publications with reflection frameworks were selected from a literature and document review of environmental sustainability as a topic in the general crafts and design education in the Norwegian school subject Art and Crafts. Included in the review were also a few highly relevant publications from other areas of design education and from other countries. The review was conducted through searches in journals (i.e. *FormAkademisk – Research Journal for Design and Design Education*, *Techne Series – Research in Sloyd Education and Craft Science A*, *Nordic Journal of Art and Research and Studies in Material Thinking*), database engines (i.e. *Education Resources Information Center [ERIC]* and *Open Digital Archive [ODA]*) and conference proceedings (e.g. *The International Conference on Engineering and Product Design Education [E&PDE]*). The review was concluded in 2020.

The publications located were organised according to their focus and methods' emphasis on the ideological, formal, perceived, operationalized and experiential levels in curriculum inquiry (Goodlad, Klein & Tye, 1979). In these, frameworks for students' reflection were found in publications based on perceived interpretations in research (Lutnæs, 2015b, 2017), operationalized educational practice (Bråten & Kvalbein, 2014) and experiential learning among students (Hofverberg & Maivorsdotter, 2018; Maus, 2019a, 2019b).

The frameworks for students' reflection were analysed according to the Model of educational practice in design for sustainability (DfS) to locate their focuses regarding the influence between students, design products and environmental impacts, and some of these (Bråten & Kvalbein, 2014; Lutnæs, 2017; Maus, 2019a, 2019b) were discussed in my PhD thesis (Maus, 2020). In the research for these papers on topics of reflection about why and how in design, the scope concerned three publications written in English (Hofverberg & Maivorsdotter, 2018; Maus, 2019b; Lutnæs, 2017), which made them accessible to a larger group of readers. The different areas of focus are visualised in a variation of the Model of educational practice in DfS (Figure 1).

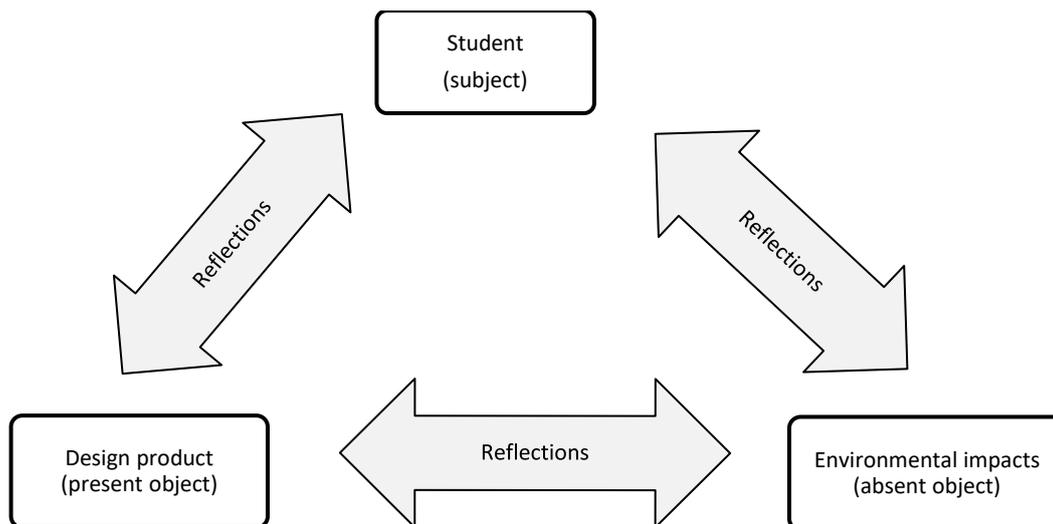


Figure 1: This model is a variation of the Model of educational practice in design for sustainability (Maus, 2017, 2019a, 2019b, 2020). The model structures a selection of frameworks for students' reflections according to their focus of attention on the following relations: (1) student–design product (Hofverberg & Maivorsdotter, 2018), (2) design product–environmental impacts (Maus, 2019b) or (3) student–environmental impacts (Lutnæs, 2017).

This model outlines students' engagement with the influences between the student (the subject), his or her design product (present object), which is present in the school studio, and the products' potential environmental impacts (absent object) which are absent from the school. The structuring of the three selected frameworks for students' reflection displays their different focus with respect to reflections about the why and how of actions in design. These involve focus on:

- Student–design product relationships through transacting with product ideas, materials' capabilities and remake techniques: This research is situated in a remake project with used-garments in the craft subject educational sloyd in Sweden in 2015, in which 15 students in the eighth grade participated. The data consisted of 20 hours of video recordings (Hofverberg & Maivorsdotter, 2018). The paper presented an analysis of the students' learning process and dialogs with their teacher. This research method focused on students' experiential learning during the operationalized educational practice.
- Design product–environmental impacts through introductions and tasks during practice and product assessment in craft-based design for sustainability (DfS): This research was situated in a woodworking project an art and crafts class in Norway in 2015-2016, where two teachers and 26 eighth-grade students (aged 12–13) in two groups participated. The data, constructed through action research, consisted of video recording transcripts with timekeeping and observation notes from one group (18 lessons, 27 hr total) and students' project books with tasks and self-evaluation responses (N = 24; Maus, 2019b). Hence, this research method focused on the on the students' experiential learning during and after the operationalized educational practice.
- Student–environmental impacts through confrontation, exploration, evaluation and transformation of consumption culture: This research was conducted through analysis and discussion of key texts on reflective inquiry (Dewey, 1933 [1910]; Schön, 1983; Freire, 1970) and methods from systems- oriented design (Lutnæs, 2017). This research method focused on researchers perceived interpretations presented in research.

The structuring of these three frameworks for reflection shows how the frameworks complement each other by focusing on the different areas, and thereby contribute to the development of different aspects of students' critical design literacy.

The topics of reflection on action in the articles were derived from a thematic analysis (King & Horrocks, 2010) with: (1) descriptive coding done by highlighting and extracting the frameworks for reflection and relevant reflection descriptions; (2) interpretive coding of the topics of reflections on the why, how and what of action in the frameworks and reflection descriptions; (3) defining overarching themes that describe the pattern of how the focus of attention affect the topics of reflection.

Reflection practices

The three selected frameworks for promoting students' reflection in design education have their similarities, but also their differences in aims, focuses of attention, steps and topics of reflection. An analysis of these frameworks show that their focus of attention affected the topics of reflection about how and why in action. Moreover, how researchers, teachers and students have different perspectives on whether the topics of reflection operate within or aim to transform established fields of practice.

Remake project with transacting relations

The students' engagement with the crafting of a design product with reuse materials is in focus in the work by Hofverberg and Maivorsdotter (2018), where they examine the students' learning processes in a remake project. Their analysis of students' learning processes consists of the purposes of the events in the remake process and the gaps the students must fill to achieve these purpose. Moreover, the relations they use to fill these gaps, including their aesthetic judgements of experience that move towards or away from fulfilment of the purpose, and finally the encounter between the students, their teacher, their peers and the physical world. The three-step framework derived from the result of this analysis encompass three categories of students' transacting relations:

1. Transacting with the idea of a product. The reflection topics in this step concern what kind of product to make from the reuse materials.
2. Transacting with a material's capabilities. The reflection topics in this step concern what is a doable use of the reuse material.
3. Transacting with remake techniques. The reflection topics in this step concern what is an appropriate technique for making the new product.

Questioning the fields of remake practice

The different perspectives on the remake practices guide interpretations of whether reflections about what kind of product to make, what is a doable reuse of materials and what is an appropriate technique for the students remaking of one object into something new operates within or aim to transform established fields of remake practice.

The researchers in this project asked questions about why students should learn to practice remake techniques. The researchers studied the learning outcomes of reuse projects and how they contributed to environmental and sustainability education (ESE), as they noted that research generally only assumes that remake leads to ESE learning outcomes. Hofverberg and Maivorsdotter (2018) emphasised ESE concerns related to human–material relationships and calls for cautions and contra-action in the remake projects. Their research results indicated that the students' ideas and bodies, as well as the used material and the teachers' knowledge, were transactants in the transactions during the students' learning process. The students' reflections were based on both positive and negative aesthetic experiences of how the product, materials and techniques could serve the intended function of the product (Hofverberg & Maivorsdotter, 2018).

The teacher carried out the remake projects of this study in 8th grade in the Swedish craft subject educational sloyd. Throughout the educational practice, the teacher expressed knowledge and cultural practice on ideas of the products, the materials' capabilities and remake techniques. The teacher asked the students' questions, informed them and guided them on choices in the design, including the selections of materials, the ideation of the products to make and crafts techniques to employ in the remake process (Hofverberg & Maivorsdotter, 2018).

The students' field of remake practice was developed and established through their own practice together with their fellow students in the school studio. The students started out with their reuse materials and used garments, from which they were to ideate and design new products. During the process of designing, the students were transacting with the idea of the product, the materials' capabilities and the remake techniques. When the students ran into challenging situations, either they asked their teacher for assistance or the teacher approached to support them. The students' reflected upon the teachers' responses, questions, information and instructions and discussed these with the teacher and each other. The questions concerned the topics of what kind of product to make, what the remake materials' qualities are, what kind of new products these material qualities were suitable for and what a suitable technique for the making of the new product was (Hofverberg & Maivorsdotter, 2018). These topics of reflection between the students and the teacher focused on the what of actions rather than the why or how. There was an agreement that they were to practice remake, but not about how to practice that remake. Instead, the questions of what to practice in remake took a position between the why and how by indicating that there could be more than one possible solution on

what materials to choose, what product to make and what techniques to use. Through the project, the students developed and transformed their own knowledge and skills concerning qualities in products, materials and techniques which are needed to rethink and transform unsustainable practices of waste disposal into practices of material reuse.

Introductions and tasks in craft-based design for sustainability

The students' engagement with the influences between their design products and the products' environmental impacts were the focus in the work by Maus (2019b), which investigated the embedding of design for sustainability (DfS) in the students' creation of a craft-based design product. The two-step framework to enhance students' reflection encompasses:

1. Practice in craft-based DfS, with introductions and tightly structured tasks based on examples of DfS principles and practices during decision-making situations about the design in sketches, work drawings and material selection when making a product. The topics in this step concern why practices for product durability and efficient, circular use of resources are environmentally considerate and what the students' use of these practices in their product consist of.
2. Product assessment after craft-based DfS, with introductions and tightly structured tasks on examples of DfS principles and practices in a project book. The topics in this step concern why practices for product durability and efficient, circular use of resources are environmentally considerate and the students' use of these practices in their product.

Questioning the fields of craft-based design for sustainability practice

The different perspectives on craft-based DfS practices guide interpretations of whether reflections about why practices for product durability and efficient, circular use of resources are environmentally considerate and the students' use of these practice in their product, operate within or aim to transform established fields of craft-based DfS practice.

The researcher in this project asked questions about why students should learn to practice DfS in craft-based design and how this can contribute to education for sustainable development (UNESCO, 2005a). Maus (2019b) selected a theory of task sequencing to support students' learning (Edwards, 2015) and theories of DfS principles and practices, and employed these in the development of the framework for students' reflections on environmental concerns in their craft-based product design. The DfS principles were life cycle thinking (LCT) about products' life cycles with their environmental impacts due to raw-materials extraction, manufacturing, distribution, use and disposal (Heiskanen, 2002) and the triple bottom line (TBL) aims for sustainability with environmental quality, social equality and economic prosperity (Elkington, 1999). The DfS practices were design for eco-efficiency, with low cradle-to-grave use of resources (Cooper, 2005, 2010), and eco-effectiveness, with the circular use of resources from cradle to cradle (McDonough & Braungart, 2009, 2013). Moreover, design for product durability and longevity through intrinsic product qualities, outer aesthetic product qualities (Cooper, 2005, 2010), functional product qualities (Stahel, 2010) and emotionally durable products (Chapman, 2009, 2010, 2015). The use of task sequencing and DfS theories aimed at enhancing learning established ideas about how to practice environmentally considerate design, but the use of these in craft-based design transformed and expanded these ideas.

The teachers collaborated with the researcher in this action-research project in eighth grade in the Norwegian school subject Art and Crafts. Together, they developed introductions and tightly structured task in seven interpretive themes, which established and exemplified the DfS practices in the students' craft-based design processes and the product. The themes were design and sustainability; functional design; accuracy in craft; materials with sustainable life cycle; construction, repair and maintenance; and value, price, wages and material costs. The introductions and tasks related to current knowledge and cultural practice in the field craft-based design education, and embedded DfS methods for environmentally considerate design in these (Maus, 2019b).

The students participated in the development of the field of craft-based design practice in general education to include DfS. They engaged in the introductions and tasks during decision-making situations about the design in sketches, work drawings and material selection when making their product, as well as during the product assessment after making the product. The introductions and tasks concerned why the practices for product durability and efficient, circular use of resources are environmentally considerate and what their use of these practices in their design product were. Through the project, the students developed knowledge and skills about ways to practice DfS, including reflecting on the product materials' life cycle and developing solutions for intrinsic, aesthetic, functional and emotional product qualities. Though this, they learned general design

methods for questioning products' potential environmental impacts and products' environmental information, which they can use on both self-made and professional products. Thus, the students developed competences to practice within established fields of practice, as well as to question and transform them.

Reflective inquiry on consumption culture

The students' engagement with the environmental impacts of their consumption were the focus of the work by Lutnæs (2017). The framework structured a reflective inquiry for students to rethink consumption culture, with the aim of enhancing the skills to rethink and transform patterns of unsustainable practices in the consumption of products. This four-step framework consisted of:

1. Confrontation, which challenges personal encounters with the world. The topics in this step concern the students' consumption and whether the consumption improves life quality.
2. Exploration of the status of current sociocultural realities. The topics in this step concern what the students' consumption habits are and who the stakeholders in their consumption are.
3. Evaluation and gaining awareness of reality. The topics in this step concern what the possible consequences of their consumption are.
4. Transformation of understandings, situations and practices. The topics in this step concern what the possible solutions for improvement are.

Questioning the fields of reflective inquiry about consumption culture

The different perspectives on reflective inquiry about consumption will guide the interpretations of whether reflections on consumption habits, their effects on life quality, stakeholders, consequences and habit improvements, operate within or aim to transform established fields of consumption and reflective inquiry. The researcher in this project asked questions about why students should learn to practice reflective inquiry, and how this can contribute to education for sustainable consumption (United Nations Environment Programme [UNEP], 2010). Lutnæs (2017) developed this framework through a review of key texts on reflective inquiry (Dewey, 1933 [1910]; Freire, 1970; Schön, 1983) and systems-oriented design (Sevaldson, 2011). These key texts describe reflective practice as inquiry that involves a state of perplexity with critical consciousness of un-preferred situations as transformable. The overall aim was to develop a reflective inquiry practice based on established practices for reflective inquiries, which could enhance students' skills to rethink and transform patterns of unsustainable practices of product consumption (Lutnæs, 2017).

The construction of data about teachers is not part of this research, but examples of how the framework may be used in teaching practices are included in the paper. The first example encompasses confrontation about the gift economy (about why we buy gifts to those we love when the environmental and social costs are not included). This had the aim of encouraging sustainability on the micro-level of everyday habits. The second example consisted of confrontation about how ideas of newness drive consumerism without improving life quality. This example had the aim to promote sustainability on the macro-levels of economic and social systems. Both confrontations included an exploration phase with GIGA-mapping in a collage with text and images, evaluation and transformation phases, with exploration of future scenarios concerning improvements to the situations (Lutnæs, 2017). Thus, the examples for teaching practice operate within the established practice of reflective inquiry, but aim to transform established fields of consumption practice.

The construction of data about students' development of skills to rethink and transform unsustainable consumption practices were not included in the research (Lutnæs, 2017). Thus, the students' potential learning outcomes were based on the inquiry framework and the examples for teaching practice, which thoroughly scaffolded the students' development of skills to rethink and transform their consumption practice. However, although the aim of the framework was to strengthen the students' competence within a specific reflective practice, the students' learning outcome from using this practice may be broader than that. This is because, in learning processes, students employ their critical thinking, judgement, will and imagination. Through this they develop their knowledge of the topic (Maus, 2020). Furthermore, through the GIGA-mapping of the potential consequences of their consumptions, the students also experienced each other's ways of performing the reflective practice. Thus, the students participate in the development and establishment of their fields of reflective inquiry on consumption culture.

Summing up the reflection practices

The three selected frameworks for promoting students' reflection in design education have similar nature, but also their differences. Descriptions of the three selected frameworks show that they have different aims, focuses of attention, steps and topics of reflection. By extracting and thematically analyzing the topics of

reflection described in the frameworks, a pattern concerning how the focus of attention affected the reflection topics emerged. Moreover, that the use of the topic of reflection on action were richer than only why and how, because reflections of what of actions also occur frequently. The main results were:

1. The topics concerning the how of action were emphasized in reflections on design products, while the questions about the why of action were emphasized in reflection on potential environmental impacts. In addition, the topics concerning does of action were emphasized in reflections on confrontations of environmental impacts from actions in one of the frameworks, but this does not make a pattern across the three frameworks.
2. The topics concerning the what of action were emphasized in relation to both design products and environmental impacts in the situations when multiple actions were possible.

The analysis results of the review are structured in the table below (Table 1).

Table 1: This table visualizes the most important aspects included in the analysis: the focus of attention; frameworks for reflection; and topics of reflection on the why, how and what of action.

<i>Focus of attention</i>	<i>Frameworks for reflection</i>	<i>Topics of reflection on the why, how and what of action</i>
Student– design product	Transacting relations: <ol style="list-style-type: none"> 1. Transacting with the idea of a product 2. Transacting with a material’s capabilities 3. Transacting with remake techniques (Hofverberg & Maivorsdotter, 2018)	<ol style="list-style-type: none"> 1. What kind of product to make from the reuse materials? 2. How can material be used for specific product? / What is a doable use of the reuse material? 3. How is a product constructed and crafted? / What is an appropriate technique for the making of the new product?
Design product– environmental impacts	Introductions and tasks in <ol style="list-style-type: none"> 1. Practice in craft-based design for sustainability 2. Product assessment after craft-based design for sustainability (Maus, 2019b)	<ol style="list-style-type: none"> 1. Why are practices for product durability and efficient, circular use of resources environmentally considerate, and what is your use of these practices in your product? 2. Why are practices for product durability and efficient, circular use of resources environmentally considerate, and what is your use of these practices in your product?
Student– environmental impacts	Reflective inquiry to rethink consumption culture <ol style="list-style-type: none"> 1. Confrontation 2. Exploration 3. Evaluation 4. Transformation (Lutnæs, 2017)	<ol style="list-style-type: none"> 1. Does consumerism improve life quality? 2. What are your consumption habits, and who are the stakeholders in your consumption? 3. What are the possible consequences of your consumption? 4. What are the possible solutions for improvement?

The analysis indicate that the potential for enhancing students’ critical design literacy cannot be understood solely in terms of the use of how and why topics in reflection on the design products and their environmental impacts. This because the use of reflection topics are more nuanced. Moreover, the topics can be interpreted and rephrased to shift the focus between how, why or what topics of reflection on design products and their environmental impacts.

However, the critical reflection also relates to questions of whether one operates within established fields of practices or aims to transform them, when working with the design products and their impacts on the world outside the school studio. This is a more compound issue, because the students, teachers and researchers in general education have different perspectives on what the established practices of the field are. Therefore, this review leads to discussions of different perspectives of how the frameworks for reflection help students operate within established fields of practices and to transform them. Thus, these frameworks’ potential to support students’ development of critical design literacy.

Critical design literacy through reflection in design

This research paper started with the concept of critical design literacy and the aim of studying how three frameworks for reflection in design education can support students’ development of the critical design literacy competence. The results of this study indicate that the focus of attention on the design product or its potential environmental impacts influence the topics of reflection. Topics concerning the design products focus on the practical how of action, while topics about environmental impacts focus on reasoning about the why of action. In addition, reflection topics about what of action were employed when multiple actions were possible in relation to both design products and environmental impacts. The discussion showed that the review of why-

and how-topics in reflection only illuminate one aspect of how to support students' development of critical design literacy.

The discussion of whether the frameworks for reflection support students' competence to operate within established fields of practice as well as to transform them are more complex. The researchers, teachers and students have different perspectives on what the established fields of practice are, and the discussion must conclude that all three frameworks for reflection in design have the potential to support the students' capacities to operate within, question and transform their field of practice.

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