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Photoreflexivity: supporting reflexivity for students in design education

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This paper describes the development and evaluation of the pedagogical photo-based method PhotoReflexivity. The method is developed to foster reflexivity for students in design education. Reflexivity plays a crucial role in guiding students to comprehend and position themselves in the external world and in providing them with an ethical framework to guide their actions. To uncover the value of PhotoReflexivity, mixed research methods including the utilisation of prototypes were deployed in authentic learning scenarios with design students. The results suggest that PhotoReflexivity may address a gap in design education by targeting extensive learning outcomes associated with reflexivity, which prior research has acknowledged as hard to achieve. It does so by providing prototypes that encourage the process of sharing and interpreting self-made photos, as steppingstones to fostering reflexivity. Through increased reflexivity, students might become more autonomous thinkers and responsible innovators, capable of navigating the uncertain and dynamic world of today.

Keywords: photo-based methods; sharing; interpreting; research through design

1 Introduction

Capable design students should understand their accountability as professionals in societies of the future (Fry, 2020; Mezirow, 1990; D. Schön, 1983). For example, they should be able to critically examine their impact as designers in a post-pandemic era, and their stance on designing for a sustainable and inclusive future. To address this, supporting students in reflexivity is crucial. Reflexivity encompasses the examination of the self, including personal values and assumptions, in a back-and-forth process of 'bending back' thoughts about the world upon the self (Archer, 2010), and takes place in communication and interaction with others (Vandenberghe, 2010). Through reflexivity, students are supported to think more autonomously and act responsibly. Also, reflexivity helps design students become more creative. By exploring their own perspectives, students can develop a

unique design approach and original design solutions that stand out from the crowd (Fry, 2020; Moon, 1999; Norman, 1993).

Although the need to educate students in becoming more reflexive is acknowledged (Archer, 2010; Baxter Magolda & King, 2012; Boud et al., 1985), a notable challenge with assignments addressing reflexivity is the lack of engagement of students and the resulting shallow and insignificant learning outcomes (Kinkhorst, 2010; Mittendorff, 2014). This negative attitude may be attributed to students' lack of confidence in their capability to draw insightful reflexive conclusions (Mittendorff, 2014) and to the inclination to mask difficulties in verbally expressing reflexive thoughts (ten Brink et al., 2021). Moreover, the often individually performed assignments addressing reflexivity neglect the potential positive impact of communication and idea-sharing on the reflexive outcomes (Vandenberghe, 2010) and on students' engagement (Diem et al., 2017; Prilla, 2014; Prilla et al., 2015).

In this paper, the proposal is put forth that photo-based methods hold promising prospects for fostering reflexivity among design students. It responds to the call of the design community to develop effective methods and instruments to increase reflexivity (Baumer, 2015; Baumer et al., 2014; Bentvelzen et al., 2022; Fleck & Fitzpatrick, 2010). The development and impact of the method PhotoReflexivity is presented, which uses self-made photos of students to support reflexivity and is inspired by the action research method Photovoice (Tinkler, 2013; Wang, 1999; Wang & Burris, 1994). Like Photovoice, PhotoReflexivity employs the ability of self-made photos to engage people and to communicate personal narratives related to the self, which is crucial for reflexivity. The contribution of PhotoReflexivity is its practical applicability in the educational domain, and its additional support for the process of sharing and interpreting self-made photos among students, serving as steppingstones to fostering reflexivity.

In the next section, current approaches to reflexivity support in education are presented and the potential of photo-based methods is acknowledged. Then, examples of photo-based methods and instruments in education are discussed from the perspective of design and a novel design space for photo-based methods, founded on sharing and interpreting self-made photos, to foster reflexivity in education is uncovered. The paper continues with an overview of PhotoReflexivity and the used approach for developing and evaluating this method. The final sections present insights and recommendations for education and design. With PhotoReflexivity, this paper aims to contribute to the important topic of getting design students to meaningfully engage in reflexive assignments and support them in becoming the autonomous, responsible designers of today and tomorrow.

2 Related work

Reflexivity and related concepts have received considerable attention in education (e.g. Archer, 2010; Baxter Magolda & King, 2012; Boud et al., 1985; King et al., 2009; Mezirow, 1990; D. Schön, 1983; van Manen, 1991) and in the design community (e.g., Baumer, 2015; Bentvelzen et al., 2022; Fleck & Fitzpatrick, 2010). This section first unravels and compares the concepts of reflexivity and the more commonly employed concept of reflection. Then, approaches, methods and instruments for supporting reflection and reflexivity in education are outlined and the potential of photo-based methods is acknowledged. In the final paragraph, an underrepresented design space that formed the foundation for PhotoReflexivity is revealed.

2.1 Reflection and reflexivity

The meaning and interpretation of concepts related to reflexivity, such as positionality (e.g., Adamu, 2021), self-authorship (Baxter Magolda & King, 2012; King et al., 2009), self-awareness, reflection, critical reflection (e.g., Mezirow, 1990) and self-reflection are often convoluted and overlapping. The semantic differences may seem small and the choice of using one concept over the other can be a matter of the researcher's context or preference. Descriptions of assignments and competencies in education often employ the concept of reflection, sometimes used interchangeably with reflexivity, and the impression arises that they are synonymous. However, there are crucial differences.

Reflection is defined by its focus on the examination of activities in the external world (Archer, 2010; Bolton & Delderfield, 2018). Reflexivity, on the other hand, "bends back thoughts upon the self" (Archer, 2010) and focuses on examining the self, including personal values and assumptions in relationship with the external world. In seminal 20th-century literature on reflection and learning (e.g., Mezirow, 1990; Moon, 1999; Norman, 1993; D. Schön, 1983) the term reflexivity is absent, however, within descriptions of reflection, references to the concepts of reflexivity can be recognised. Often, two kinds of reflection are described. The first aligns with the concept of reflection and refers to in-depth considerations of something outside of oneself, for example, reflecting on a designed artefact. Meaning-making occurs through assessing the performance of the design, often supported by structured evaluation criteria. The outcome is the improvement of (design) skills, which are important but at the same time limited to rule-of-thumbs insights for a specific context (e.g., D. A. Schön & Argyris, 1996).

The second kind of reflection discussed in the literature centres on the exploration of the self in relation to the external world, making it relevant to the concept of reflexivity. Examining assumptions underlying one's purposes, values, and feelings is essential (e.g., Archer, 2010; Baxter Magolda & King, 2012). Meaning-making occurs in a process of interpreting subjective information – such as values and assumptions. Outcomes include self-awareness and can be transformative, e.g., design students considering their stance on the sustainability of a designed artefact and acting upon it by adapting the design.

Finally, reflexivity differs from reflection with respect to the social and shared nature of the process. In philosophical and cognitive approaches, reflection is positioned as an almost exclusively individual activity that takes place inside the individual's head (Baumer, 2015; King & Kitchener, 1994). Reflexivity, on the other hand, is a social phenomenon, rooted in communication with others (Vandenberghe, 2010) and should, therefore, be positioned in a shared and conversational context. All are summarised in Table 1.

Table 1. Differences between the concepts of reflection and reflexivity

	Reflection	**Reflexivity**
Focus	Activities in the external world. Assessment of performance.	The self in relation to the external world. Interpretation of subjective information.
Process	Often an individual activity	Rooted in communication and sharing
Outcomes	Limited: improvement of skills	Extensive: encourages self-awareness and transformations in the self

2.2 Approaches to reflexivity in education

With a clarified understanding of the essence of reflexivity, the focus shifts to exploring approaches that foster reflexivity in education. Conventional textual approaches like Reflection reports are examined as initial reference points. Subsequently, the significance of visual approaches utilising students' self-made photos is highlighted as a promising avenue for further exploration.

2.2.1 Textual approaches

Reflection reports, -journals or -diaries (Fessl et al., 2016; Leijen et al., 2014) are common assignments for students to reflect on their learning experiences. They typically involve guided reflection based on textual prompts and consist of personal, written narratives that focus on the learning activities, what went well and what could be improved in the future. This approach focuses on supporting reflection as described in Table 1.

A textual approach aiming for reflexivity is Creative writing, which involves focusing close attention on personal values, assumptions, identity, and social structures (Bolton & Delderfield, 2018). This approach involves looking at the self from an outsider's perspective and requires a creative leap to mix tacit and explicit knowledge. Creative writing may help students express personal values and assumptions that were previously unknown to them. It embraces imagination, various perspectives, and interpretations of subjective information, which is central to reflexivity (see Table 1).

However, are textual approaches the best option to facilitate reflexivity? Visual approaches based on photography provide an alternative and may overcome the downsides of textual methods for students with limited writing skills or confidence. Generally, photo-based approaches are perceived to exhibit a lower barrier to student engagement (e.g., Latz, 2017) and can align more effectively with students' capacity to understand and express visual language, particularly in today's visually dominant culture. Moreover, studies confirm that using photos to benefit learning for students ‘rather than offering a completely objective view of an object or a scene, provide instead a certain way of seeing it, or an idea of it’ (Cooper et al., 2017), beneficial for reflexivity (see Table 1).

2.2.2 Visual approaches, photo-based methods and Photovoice

The potential of photos to facilitate discussion about personal values and assumptions is widely acknowledged (e.g., Mendelson, 2007; Rose, 2016; Sontag, 1977). A photo can be a rich source of knowledge reaching beyond what is literally depicted and revealing personal narratives. In addition to their ability to document the world, photos can have a symbolic meaning and facilitate the interpretation of the world, crucial for reflexivity (see Table 1). This is utilised in the action research method Photovoice (Wang, 1999; Wang & Burris, 1994). Photovoice originates from sociology and aims to ‘give voice’ to marginalised people by asking them to document their lives with self-made photos for presentation to policymakers. Ultimately, the process of interpreting the photos and drawing conclusions rests with the researcher and the audience of policymakers.

This paper aims to provide evidence that photo-based methods could serve a purpose beyond gaining insights for researchers or other audiences, but instead serve as a pedagogical method for the participants themselves, i.e., students in design education, and foster reflexivity. Several photo-based methods applied in an educational context are described in the literature. Some aim to gain knowledge about students: their learning process, and their well-being (Ciolan & Manasia, 2017; Dockett et al., 2017; Latz, 2017) and do not specifically address reflexivity for students as the

intended outcome (Ali-Khan & Siry, 2014; Chio & Fandt, 2007; Cooper et al., 2017; Schell et al., 2009). Others miss the opportunity to cultivate potentially transformative insights through interpersonal communication and sharing (Kaplan & Howes, 2004; Sensoy, 2011; Wilson et al., 2007), which is crucial for reflexivity.

Limited research (e.g., Bosch et al., 2019; ten Brink et al., 2021) has focused on photo-based approaches designed to stimulate reflexive discussions among peers concerning personal values and assumptions, which may foster reflexivity. Nevertheless, challenges persist regarding verbally articulating photo interpretations to peers, in a shared process with peers, but independently from the educator, (ten Brink et al., 2021; Wilson et al., 2007). This is sub-optimal for reflexivity since being in control over own process is conducive to motivation and to the quality of learning (e.g., Winne & Hadwin, 2008). Additional support should be designed that supports students to share and interpret self-made photos, independently of the educator, as steppingstones to fostering reflexivity. The next section takes a design perspective and outlines theoretical approaches and practical, designed examples of photo-based methods from previous research.

2.3 A design perspective on reflexivity support

The design community has become increasingly interested in developing methods and instruments that support reflection and reflexivity. Theoretical frameworks to guide the design are developed, for example, three perspectives have been identified: breakdown, inquiry, and transformation (Baumer, 2015) as well as four design resources: temporal perspective, conversation, comparison, and discovery (Bentvelzen et al., 2022). Other research described five levels of reflection expressed in discourse types: revisiting, reflective description, dialogic reflection, transformative reflection, and critical reflection (Fleck & Fitzpatrick, 2010). The Collaborative Learning Mechanisms (CML) framework (Fleck et al., 2009) focuses on the collaborative aspect and suggests Mechanisms of Collaborative Discussion: consisting of 'Making and accepting suggestions' and 'Negotiating'. A focus on content (ten Brink et al., 2021) points to four 'Frames of interpretation' expressed by students when immersed in reflexive discourse: 1) Me, referring to the self, 2) The other, referring to interaction with others, 3) Culture, referring to interaction in a wider context based on established behaviour, and 4) Temporality, referring to the passing of time.

The frameworks could serve as indicators of reflexivity to analyse and code students' discussions about photos with peers. However, they do not provide insights into the practical design of photo-based methods and instruments to facilitate reflexivity in education. Moreover, design-focused research using the term Photovoice does not include designed prototypes to support the process (e.g., Jones & Baldwin, 2009; O'Leary et al., 2021). To find designed examples, research referring to the more general description of photo-based methods in education was considered.

In most found examples, photos represent documentations of the world and are used to review and assess a specific situation or activity (Fessl et al., 2016), suggesting a focus on the support of reflection (table 1). For example, INWARD (Arakawa & Yakura, 2020) supports reflection in executive coaching with video recordings of coaching sessions. The recordings are reviewed, followed by an assessment of the performance of the students in the coaching sessions. With the photographic life-logging tool SenseCam (Fleck & Fitzpatrick, 2010) photos of classroom situations are taken automatically in a predetermined interval and viewed afterwards for (teacher's) assessment and evaluation. Equally, The Research Diary (Gourlet et al., 2016) supports pupils' reflective thinking by

enabling them to take photos of their designed artefacts in different phases of development in the classroom, which are evaluated afterwards. The exception is The Air Quality Lens (De Greve et al., 2022) which utilises photos beyond mere documentation of the world. It introduces a device, placed in front of a smartphone camera, to alter photographs with a colour overlay expressing real-time data from air quality sensors. The goal is to explore how environmental data can be reactivated in realistic surroundings, to express matters of concern rather than matters of fact, indicating a shift in focus towards subjective, emotional information and interpretation of the world that may foster reflexivity (Table 1). In none of the designed examples, the potential positive impact on reflexivity of communicating and sharing perspectives on photo interpretations with peers is not fully harnessed.

In summary, insights from studies with photo-based methods in education spark further research by suggesting their untapped potential for provoking reflexivity. Unlocking this untapped potential entails directing attention to the process of sharing and the process of interpreting self-made photos among students, as steppingstones to fostering reflexivity. An attempt to do so is made with PhotoReflexivity, which is proposed and presented in the next section.

3 Overview of *PhotoReflexivity*

PhotoReflexivity is a pedagogical photo-based method, designed to support the process of *sharing* and *interpreting self-made photos*, as steppingstones to reflexivity for students in design education. It builds on the power of photos to engage students and communicate narratives related to the self, known from methods such as Photovoice, however, aims beyond documenting the world by supporting students to interpret the world, in a social and shared process with peers. It consists of two practical components for the two phases of a photo assignment: the phase of photo-taking and the phase of photo-discussing.

- *A mobile application* supporting students in sharing self-made photos with peers, in the phase of photo-taking
- *Three workboards: Photo profile, Photo story and Photo position* supporting students in verbally expressing photo interpretations in a shared process with peers, in the phase of photo-discussing.

Practical guidelines for photo assignments supporting reflexivity, included in the method, are outlined at the end of this section.

3.1 Sharing self-made photos with the mobile applications

To turn photo-taking into a process of taking *and sharing*, potentially fostering reflexivity, a high-fidelity prototype of a mobile application was designed (figure 1) (ten Brink et al., 2021). The rationale for investing in a high-fidelity prototype lies in its ability to enable participants to concentrate on the intended purpose of the technology within the context of their lives, without being distracted by speculative future developments, as is often the case with low-fidelity prototypes (Uriu & Odom, 2016). The application was made available via the App Store and Google Play Store.

The application supports students in a joint effort of taking and sharing self-made photos in a trusted shared photo grid, before meeting up in class to discuss the photos. This may encourage students to take and share photos in response to their peers and engage in a ‘visual conversation’, potentially

fostering reflexivity. Educators have the capability to form student groups and send photo assignments via notifications. The application incorporates a timer that displays the remaining time for the assignment, along with functions to upload and view photos within a shared grid or list. Interaction options include liking, represented by a heart and a star, and disliking, symbolised by throwing a tomato. The integration of both liking and disliking features has been found to enhance the quality of photos (ten Brink et al., 2016); nevertheless, the intention was to design the disliking feature in a light-hearted manner, fostering a playful experience that encourages critical yet not overtly negative responses from peers. Students have the autonomy to select their account name but are not allowed anonymity in posting. In the detailed view of a photo, the account name, photo location (if shared by the student), and timestamp are displayed.

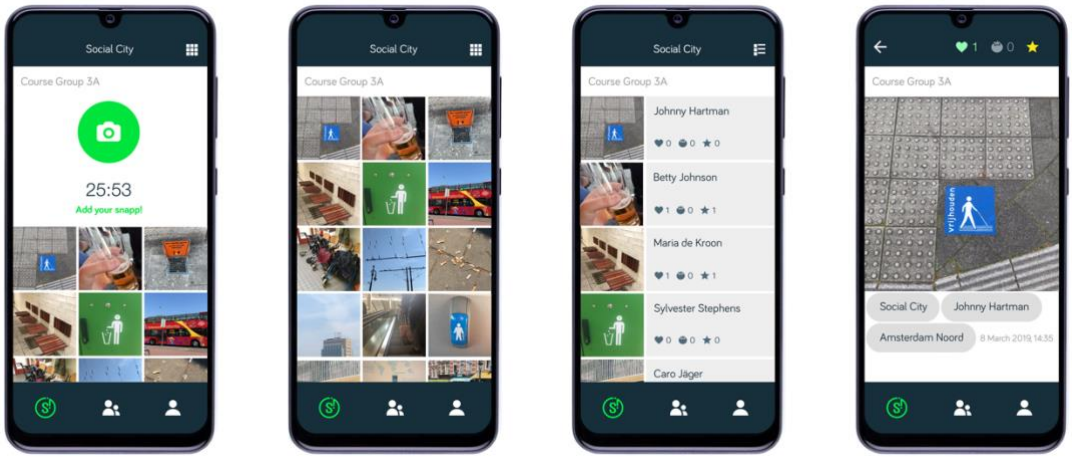

Figure 1: Key screens from the high-fidelity mobile application that allows students to engage in the process of taking and sharing self-made photos with peers, as a steppingstone to fostering reflexivity. From left to right: (1) contributing photos, with integrated timer, (2) grid view and (3) list view on shared photos, (4) detailed view.

3.2 Interpreting self-made photos with *Photo profile*, *Photo position* and *Photo story*

As mentioned earlier, verbally expressing interpretations of photos can be difficult for students (ten Brink ten et al., 2021; Mittendorff, 2014). To support the verbal expression of photo interpretations in a shared context with peers, three workboards were designed: Photo profile, Photo position and Photo story (figure 2) (ten Brink et al., 2022). Brainstorm sessions with designers and educators, as well as theories from different research domains, inspired the three designs.

Photo profile and Photo position utilise symbolic 'tags' to label the self-made photos. According to semiotic theory literature, symbolic words, such as 'social' or 'childish' provoke interpretation and association (Chandler, 2007) and add reflection-supportive complexity (Nack et al., 2014), potentially fostering reflexivity. The Product Personality Scale (Mugge et al., 2009): a set of 20 personality characteristics such as 'cheerful' or 'modest', was used for the tags in Photo profile. The characteristics were printed on labels and positioned on the board. Students can pick up one or more labels and use them to profile their photo(s) on the shared tabletop and discuss their choice with peers.

Theories of system thinking (Cabrera, 2008) and concept mapping (Novak & Cañas, 2008) inspired the design of Photo position. Opposing concepts, such as 'pessimistic' and 'optimistic' were printed

on labels. Students are encouraged to pick up a pair and position one or more photos on the imaginary axis between the two opposing concepts and discuss their stance.

The design of Photo story does not use labels but encourages students to create a story by positioning three of their photos in a 3-point narrative arc. Theories of storytelling to construct knowledge about the self (Heusden, 2009; Vandenberghe, 2010), as well as the 'Rule of Three' design approach (Lupton, 2007), inspired the design. Students are asked to create a story on the spot.

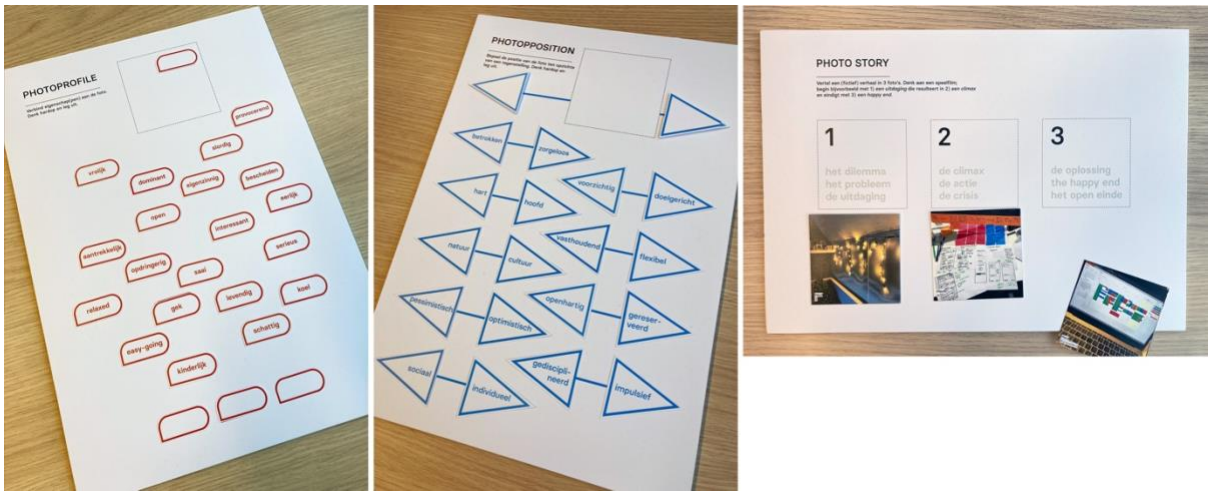

Figure 2: From left to right: Photo profile, Photo position and Photo story.

3.3 Guidelines for photo assignments

To foster students' ability to capture photos as interpretations rather than mere recordings of the world, photo assignments should ideally be framed in abstract or speculative language (Chandler, 2007). For instance, an assignment like "Social city" prompts students to explore personal values and assumptions concerning both social and antisocial aspects of society, thereby facilitating the definition of their perspective on sociality in a design project. Alternatively, assignments directly focused on the self, such as "This is important to me," might be incorporated into a course centred on professional development. These assignments are distributed by the educator using the mobile application. (figure 1). To avoid students getting stuck on a single assignment, it is advised to send out three or four assignments simultaneously and define them as different perspectives on the same topic, for example by using the 'Frames of interpretation' (ten Brink et al., 2021).

For the photo-discussing phase, it is advised to divide the students into groups of 3 to 5, to assure a manageable number of photos to discuss per group. The photos should be printed out beforehand, preferably on heavy-weight printing paper, to emphasise the quality of students' contributions. To encourage interaction with and pivoting of the photos on a shared tabletop, a square format of the photos is preferred.

The next section explains how the studies, which resulted in PhotoReflexivity, were conducted.

4 Study approach

The value of PhotoReflexivity was evaluated in authentic learning situations with design students in an inductive 'bottom-up' study approach. Through the use of designed prototypes, tendencies in students' reflexive attitudes, behaviour and conversations were identified and generalised design patterns and recommendations could be described. Research through Design (RtD), which emphasises the creation and exploration of designed prototypes and design processes to generate new knowledge (Frankel & Racine, 2010) was used as the main inductive approach. At the same time, RtD was used as a 'top-down' deductive approach, because aspects of the designed prototypes of PhotoReflexivity were based on existing theories, which were then evaluated in authentic learning contexts to confirm or refute them.

4.1 Mixed methods

The application of prototypes in authentic learning scenarios was combined with observations of students interacting with the prototypes and sharing ideas with each other. Thematic Analysis (Braun & Clarke, 2006) was used to analyse recordings of the conversations. With surveys based on statements and Likert scales, students' experiences were evaluated. To understand the motivations of students, open text fields in the surveys as well as interviews were analysed through content coding. Statistics helped to analyse quantitative Likert scale measures.

4.2 Research participants, data collection and analysis

All studies were situated in professional design education. Data were collected from students recruited through the university of the main author of this paper and consisted of Dutch students, visiting students from the UK, and a group of 16 Brazilian participants who took part in an international workshop in Brazil. In all studies, students were asked to take 4 to 10 photos of three or more course-related topics simultaneously. The time limit ranged from a couple of hours up to one week, depending on the course schedule. Students delivered a presentation and a report or video at the end, explaining and illustrating the insights, which were graded or marked as mandatory activities. The technical quality of the photos was not part of the evaluation.

The research was divided into two parts, corresponding with the two phases of photo assignments: photo-taking and photo-discussing.

4.2.1 Photo-taking

During the photo-taking phase, data were gathered from students through a survey after utilising the mobile prototype (see Figure 1) (ten Brink et al., 2021). The mobile application was designed to enable students to take and share photos with their peers, transforming the typically individual activity of photo-taking into a social, shared process. The aim of this study was to find out if and how students would feel engaged in a photo-sharing process centred around a shared topic. The argument could then be made that through (increased) social sharing and interaction reflexivity may be fostered (Vandenberghe, 2010). The study examined how specific attitudes and behaviour were affected by addressing a) students' general attitude to sharing versus individually collecting photos, b) their attitude to non-anonymous versus anonymous sharing, and c) their tendency to inspire peers versus being inspired by peers.

After using the application, 109 students completed a survey with 12 statements (6 statement pairs) on a 4-point Likert scale. To minimise the effect of 'satisficing' (Krosnick, 1991) and urge towards an

explicit positive or negative response, no 'indecisive' midpoint was supplied. The statement pairs addressed the above-mentioned attitudes and behaviour. Open text fields allowed for reflection on the perceived usefulness of photo-sharing activities. The answers to the survey were analysed using descriptive statistics and Spearman's correlation. The remarks in the open text fields were analysed through content coding.

4.2.2 Photo-discussing

In the photo-discussing phase, data were collected from students by recording their conversations and observing their behaviour while using the prototypes Photo profile, Photo position and Photo story (see Figure 2) and with a survey afterwards (ten Brink et al., 2022). The three prototypes were designed to support the process of verbally expressing interpretations of self-made photos, as a steppingstone to fostering reflexivity.

A repeated-measures user study with 15 design students aimed to uncover the effects of the three prototypes on the verbal expression of photo interpretations while discussing photos with peers. After the photo-taking period, the students met up in class. They were divided into five groups and each group was offered the three prototypes in counterbalanced order to minimise order effects. Per round, the students were asked to present their photos with the support of the prototype and to comment on their peers. A fixed procedure conducive to equal collaboration, including turn-taking (Fleck et al., 2009; Gelmini et al., 2004) and thinking out loud (Fleck et al., 2009) was followed. Video and audio were recorded for analysis later. Afterwards, the students were offered a survey with eight questions, investigating students' preferences for one of the three prototypes in terms of 1) ease of use and -collaboration and 2) support for verbally expressing photo interpretations. An open text field included in each question invited students to motivate their choice. The conversations of the students were transcribed and analysed using the CML framework (Fleck et al., 2009) as indicators for reflexivity. Remarkable interactions suggesting differences between the three work boards were identified by analysing the video recordings. Also, the quantitative and qualitative answers to the survey were analysed.

5 Insights and recommendations

This paper aimed to provide insights into how to support students in sharing and interpreting self-made photos using the pedagogical method PhotoReflexivity, as steppingstone to fostering reflexivity. By analysing students' attitudes and behaviour as well as the content of their conversations, conclusions could be drawn and recommendations for Designing for reflexivity could be given. In this section, these recommendations are summarised. Then, we zoom out to position PhotoReflexivity in design education and discuss future work.

5.1 Recommendations to support sharing of self-made photos

Sharing of self-made photos was improved by providing a mobile application (Figure 1) that turns the individually performed phase of photo-taking into a process of photo-taking and -sharing (Figure 3). The studies provided insights into the effects of the mobile application on sharing in terms of the attitudes and behaviour of students (ten Brink et al., 2021). The findings revealed positive student attitudes towards sharing photos within the educational context. Further examination highlighted a preference for non-anonymous sharing compared to anonymous sharing. Moreover, the prospect of inspiring peers emerged as a significant motivating factor for students to share their photos,

outweighing the influence of being inspired by peers. As a result, it is recommended to encourage immediate and open (non-anonymous) sharing of self-made photos among peers and to cultivate students' desire to take on a leading role in inspiring their fellow students. This can be achieved through strategies such as showcasing students' impact within the group, implementing a reward system for original photos, or providing social cues that indicate the interest of others, such as the number of views.

In the phase of photo-discussing, sharing was improved by providing three prototypes that formed a shared focus and activity. For effective sharing, it is recommended to follow a fixed procedure of turn-taking (Fleck et al., 2009; Gelmini et al., 2004) and thinking out loud (Fleck et al., 2009).

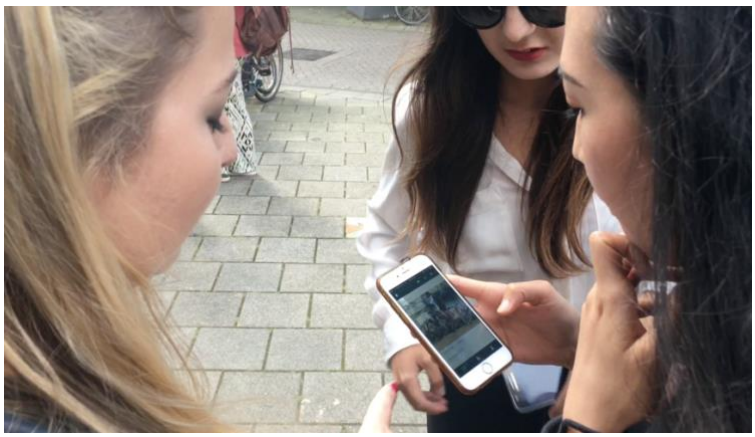

Figure 3: Students involved in taking and sharing photos with the mobile application.

5.2 Recommendations to support verbal expression of photo interpretations

The verbal expression of photo interpretations in the phase of photo-discussing was improved by each of the three prototypes in its own way (ten Brink et al., 2022). It was found that Photo profile provokes quick (verbalised) suggestions from students and is therefore considered the easiest-to-use of the three. Photo story is considered the most difficult to use, however, more than the other two, it provokes humour and allows students to express an idiosyncratic and unorthodox part of themselves. Finally, Photo position provokes a nuanced view on own professional identity, including perceived limitations or personal hurdles.

Building on these insights, it is recommended to use language triggers (‘tags’ or words on labels) and/or language structures (narrative arc, oppositions) to support the verbal expression of photo interpretations. Also, abstract words such as ‘optimistic’ or ‘modest’ may work better to trigger interpretations of the world than fixed or descriptive words such as ‘yellow’ or ‘big’. Empty labels for additional input from students, emphasise the personal, interpretive nature of the assignments.

Providing students with diverse forms of support is advised (Figure 4). In the conducted studies involving three prototypes, none distinctly emerged as the most effective means for facilitating the verbal expression of photo interpretations. The preferences of students varied, with indications that a combination of the prototypes proved to be the most supportive for them.

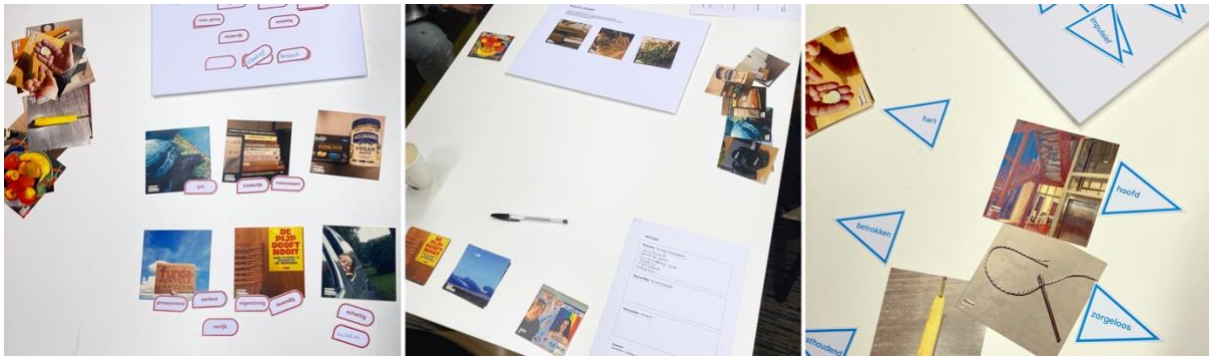

Figure 4: Photo profile (left), Photo story (centre) and Photo position (right) being used by students in a classroom setting.

5.3 Positioning *PhotoReflexivity* in education

PhotoReflexivity could play a distinct role in fostering reflexivity for students in design education. To highlight its attributes, a comparison is drawn with Photovoice, a main source of inspiration (see Table 2). Compared to Photovoice, PhotoReflexivity incorporates additional instruments to support sharing and interpreting self-made photos, as steppingstones to fostering reflexivity. In PhotoReflexivity, photo assignments are formulated as abstract topics related to the study program, such as 'Social city' or 'This is important to me.' Focusing on abstract topics elevates the strength of the method to facilitate meaning-making through interpretation rather than mere documentation of the world. In Photovoice, the photos primarily function as rich visual data, later interpreted by researchers, educators, and other audiences. In contrast, PhotoReflexivity shifts the reflexive learning process of interpreting photos to the students, utilising the photos as triggers to engage in discussions about personal values and beliefs. An overview of all attributes is provided in Table 2.

Table 2: Key attributes of PhotoReflexivity, illustrating its emphasis on facilitating reflexivity, compared to Photovoice.

	Photovoice	***PhotoReflexivity***
	Building on the ability of self-made photos to: • Engage participants (students) • Communicate personal narratives related to the self	
Support for collaboration	No support during photo-taking Limited support during photo-discussing	Yes, with mobile prototype during photo-taking With *Photo profile*, *Photo position* and *Photo story* during photo-discussing
Support for verbalisation in the photo-discussing phase	No	Yes, with *Photo profile*, *Photo position* and *Photo story*
Assignment to take photos of:	Daily life in general, supporting documentation of the world	Abstract topics related to the study program, supporting interpretation of the world
The photos serve as:	Rich visual data and qualitative insights for researchers	Triggers for discussion and qualitative insights for students
Responsibilities and roles	Photo interpretation mainly by researchers and other audiences	Photo interpretation by students

5.4 Implications and future work for design education

Zooming out further, it is argued that the practical contributions of PhotoReflexivity translate the theoretical discourse about the need for reflexivity in design education (e.g., Norman, 1993; D. Schön, 1983) into a learning scenario that brings reflexivity into practice. PhotoReflexivity activates students to 'bend back thoughts upon the self' (Archer, 2010) and engages students via self-made photos in processes and interactions that could act as steppingstones to fostering reflexivity. This is an important learning advantage since reflexivity can be hard for students, and engaging in it is not a given fact (Kinkhorst, 2010; Mittendorff, 2014). Educators are invited to further explore the integration of PhotoReflexivity in their courses with the important goal of educating students to become autonomous and responsible design professionals.

Moreover, PhotoReflexivity has the potential to contribute to the ongoing discourse concerning the necessity for practical and creative methods to explore contemporary impractical challenges, characterised by subjectivity and ill-defined nature (Sipos & Wenzelmann, 2021; Tylosky et al., 2021). It offers a means to grapple with their complexity and abstract nature. PhotoReflexivity could be utilised in research assignments for students as a method to investigate the values and assumptions of others within complex contexts. The wealth of qualitative data that can be unearthed through this approach is of great significance for design students, as understanding reflexive conversations among participants and exercising empathy are crucial skills for future design professionals.

5.5 Implications and future work for the design community

The design community is invited to take up the challenge of Designing for reflexivity with photo-based methods in design education. The practical prototypes of PhotoReflexivity may be used as a starting point to further explore and evaluate the topic of reflexivity support in design education.

PhotoReflexivity is anticipated to demonstrate adaptability beyond the realm of design education, as the process of 'bending back thoughts - relating specific concepts pertinent to the domain - to the self' (Archer, 2010) is fundamental to developing autonomy and responsibility in professionals across various domains. Nonetheless, variations in the verbal expression of photo interpretations among students, outlines in this paper, may suggest the necessity of exploring potential disparities between individual learners, linked to their learning styles, as well as variations in cognitive capacities, which could be associated with age differences.

Also, a digital interactive environment for Photo profile, Photo story and Photo position to support photo-discussing could be designed and integrated with the mobile application for photo-sharing. Utilising the digital domain could be beneficial for a pandemic-sensitive society as well as for learning scenarios crossing cultural and geographical borders. Features such as selecting pre-defined labels or writing your own could be enriched with contextual information via web technologies, to further enhance the reflexive process. Also, specific interactions induced by the three prototypes such as (spatial) clustering of photos, and sequential arranging of photos into narratives could be further explored in the digital space. Finally, the design of methods and instruments for evaluation and feedback on photo assignments could be a fruitful line of research. This includes individual evaluation and feedback by educators, but also the sharing of group results with other groups as a means of meta-reflexivity between students with different (cultural) backgrounds.

6 Conclusion

This paper has introduced the photo-based method PhotoReflexivity and demonstrated its value for fostering reflexivity for students in design education. The findings indicate that PhotoReflexivity encourages students to engage in processes that can serve as essential steppingstones to fostering reflexivity, namely, the process of sharing and the process of interpreting self-made photos. Although the usage of PhotoReflexivity may be limited in this study, it is believed that further exploration and implementation of the method can yield even more substantial benefits. Future work includes designing an integrated digital system to further enhance photo-taking, sharing, and discussing, which would be particularly beneficial for remote learning scenarios and promote cross-cultural collaboration. The ultimate goal of this research is to contribute both theoretical and practical knowledge to the vital mission of design education: fostering students' reflexivity, which previous research has considered hard to achieve. The potential impact of fostering reflexivity through PhotoReflexivity holds promise for the enhancement of design education and the preparation of students for their roles in shaping our ever-evolving world.

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