INWARD: A Computer-Supported Tool for Video-Reflection Improves Efficiency and Effectiveness in Executive Coaching

Riku Arakawa^{*} The University of Tokyo Tokyo, Japan arakawa-riku428@g.ecc.u-tokyo.ac.jp Hiromu Yakura^{*†} Teambox Inc. Tokyo, Japan hiromu@teambox.co.jp

ABSTRACT

Video-Reflection is a common approach to realize reflection in the field of executive coaching for professional development, which presents a video recording of the coaching session to a coachee in order to make the coachee reflectively think about oneself. However, it requires a great deal of time to watch the full length of the video and is highly dependent on the skills of the coach. We expect that the quality and efficiency of video-reflection can be improved with the support of computers. In this paper, we introduce INWARD, a computational tool that leverages human behavior analysis and video-based interaction techniques. The results of a user study involving 20 coaching sessions with five coaches indicate that INWARD enables efficient video-reflection and, by leveraging meta-reflection, realizes the ameliorated outcome of executive coaching. Moreover, discussions based on comments from the participants support the effectiveness of INWARD and suggest further possibilities of computer-supported approaches.

Author Keywords

Executive coaching; Video-Reflection; Meta-reflection

CCS Concepts

•Human-centered computing → Computer supported cooperative work; *HCI* design and evaluation methods; •Information systems → Collaborative and social computing systems and tools;

INTRODUCTION

Reflection is an essential process of learning [11]. The importance of reflection is not limited to classrooms, as it is also emphasized in professional development [55, 39]. One representative area is executive coaching that typically consists

CHI '20, April 25-30, 2020, Honolulu, HI, USA.

http://dx.doi.org/10.1145/3313831.3376703

of one-on-one sessions between a coach and a coachee [13, 34]. Through a conversation and inquiry, the coach guides the coachee reflectively think about their experience or behavior in order to achieve the coachee's goal, such as gaining self-awareness or developing leadership [32, 44, 56]. For example, Sherman et al. [56] explained the distinction of reflection in executive coaching using the metaphor of a window and mirror: the purpose of executive coaching is to provide coachees with more time to look into the mirror instead of looking through the window.

Video-Reflection is a popular technique to shepherd the reflection process by recording the conversations and replaying them to the coachees [58, 35]. Some practitioners recommend that coaches as well watch the recorded videos to nurture their coaching skills [26, 10]. Due to the simplicity of this approach, i.e., just recording videos and playing back, it is also widely used in school education [25, 7], sports [8, 23], and dance [37].

Despite its popularity, a disadvantage of video-reflection is the extended time necessary for the video playback of a session that can last around an hour [6]. Moreover, it is pointed out that video-reflection lacks a systematic and organized approach [47, 38], which makes outcomes highly dependent on individual skills. Considering these issues, we are interested in how computers can contribute to video-reflection in executive coaching. In particular, as Otte et al. [45] observed, studies that utilize computers to develop systematic approaches in executive coaching are lacking, so we anticipate a large room for improvement.

For example, coachees would not necessarily need to watch an entire video recording considering it contains non-relevant scenes, such as an icebreaker conversation or pauses during note-taking. If the coachees are offered a summarized version that extracts the essential parts of the session, then similar results should be expected while reducing the time to perform the reflection. However, manually preparing this type of video by a coach requires significant time and is challenging. In recent, many methods to analyze human conversation by leveraging computer vision technologies have been proposed in the context of social signal processing [61] and human activity analysis [1]. By providing a tool that combines these methods for the purpose of video-reflection, we expect an improvement in the quality and efficiency of the reflection process.

^{*}These authors contributed equally and are ordered alphabetically.

[†]Also with University of Tsukuba, Japan.

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than the author(s) must be honored. Abstracting with credit is permitted. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permissions from permissions@acm.org.

^{© 2020} Copyright is held by the owner/author(s). Publication rights licensed to ACM. ACM ISBN 978-1-4503-6708-0/20/04 ...\$15.00.

In addition, by introducing a different perspective based on human behavior analysis, we expect such a tool can support a deeper level of reflection. In detail, using the information drawn by a computer as a baseline, the coach and coachee can discuss their opinion about the session on neutral ground. This type of discussion would encourage *meta-reflection*, where the participants reflect on not only the content but also their thinking about the session. As meta-reflection leads to an enhancement of self-awareness [42, 22], providing such peer discussion between coaches and coachees should improve the effectiveness of reflection.

In this paper, based on these considerations, we implemented INWARD, a tool to support video-reflection in executive coaching. In our tool, we propose a new procedure of computer-supported video-reflection where the coach and coachee are presented scenes marked as important by a human behavior analysis algorithm [2]. Without carefully watching the entire video, they can reflect by focusing on a limited number of pre-detected scenes. After the reflection process, the tool also facilitates discussion between the coach and coachee by displaying differences between their opinions about the scenes.

To explore how computers can support video-reflection, we then conducted a user study with professional coaches using INWARD. Participants performed a series of reflection processes with and without the assistance of the tool, and we compared the effectiveness and efficiency of the reflection between the two groups. Our quantitative and qualitative analyses suggest that the computer-supported approach contributed to improved efficiency of the video-reflection process. In combination with the meta-reflection process, INWARD provides significantly better efficacy compared to the conventional approach. Based on these results, we discuss the design implication of video-reflection and meta-reflection along with its relevance to prior studies. Our study presents further possibilities for computer-supported approaches in executive coaching to benefit the field of human resource development.

BACKGROUND

In this section, we present the theoretical background and related topics in executive coaching as a foundation for the following experiment. We begin with the importance of reflection in executive coaching and methods to realize the reflection. Next, we discuss the psychological effects of reflection based on previous studies. Finally, we introduce related techniques to facilitate computer-supported executive coaching.

The Key to Successful Coaching: Reflection

Although the effectiveness of executive coaching has been supported in many studies, it remains challenging to lead coaching sessions successfully. Coaches are often in a struggle with complex situations involving organizational issues, human motivation, specific skills, and political and economic realities at companies [65]. In such situations, it is pointed out that the reflection of the coachee is key to successful coaching [22]. Here, reflection is a cognitive process performed to learn from experiences by inquiring both individually and collaborating with others [11, 39]. In the case of the coaching session, coaches are required to promote the reflection, that is, coachees look back on their experiences through conversation. Moreover, reviewing the coaching session as another form of the coachees' reflection has been recognized to be as important as the coaching session itself [58].

Methods to Realize Reflection in Coaching

Following the forms of reflection in coaching mentioned above, there exists typical methods for their facilitation. A basic approach is the coach's questioning, which makes the coachee to think about oneself through responding to the questions. Outstanding coaches ask powerful, thought-provoking questions that consider the internal states of the coachee while building rapport [36, 32].

On the other hand, video-reflection is useful for realizing reflection through the review of the coaching session. Such an approach leveraging video for learning from experiences has been explored [18], especially in the context of teacher education [54]. This practice is preferred because it can provide time to reflectively think about oneself as well as an objective perspective from which the coachee can realize things unnoticed during the experience. As mentioned in the "Introduction" section, the literature emphasized the importance of video-reflection in executive coaching.

Meta-reflection is also known as an effective method that reviews a personal experience as well as the thinking around that experience [17]. Utilizing meta-reflection in coaching was introduced by Thorpe and Garside [60], who proposed a multi-dimensional reflection process consisting of sequential stages. Each stage looks back at what was thought in the previous stage. Subsequent studies showed the effectiveness of meta-reflection for enhancing self-awareness and acquiring new skills [21].

Effects of Reflection in Coaching

As reflection plays a crucial role in executive coaching, many psychological studies have been conducted to uncover what occurs in the moment of reflection [12]. Generally, reflection is considered to improve self-awareness [64]. While there exists a variety of definitions about self-awareness, most agree that represents knowing one's internal states, preferences, resources, and intuitions [19]. Self-awareness is also acknowledged as a fundamental part of human learning [69] and can produce a readiness that is essential for personal change [70]. Some studies reported that the outcome of executive coaching could be evaluated quantitatively based on the self-awareness theory [12, 14] with its index that can be calculated by answering a set of subjective questions [33].

At the same time, authenticity has been identified as another essential part related to the development of leadership that reflection can enhance [66]. Kernis introduced a definition of authenticity as "the unobstructed operation of one's true, or core, self in one's daily enterprise" [31]. The advantage of this concept is that it accounts for not only conscious selfawareness but also its relationship with both the actual physiological states and emotional expression [66]. In this respect, prior work argued that the contribution of coaching is related to authenticity and suggested the use of the Authenticity Scale instead of self-awareness as an instrument for measuring the outcome of executive coaching [59].

Computational Support in Coaching

Otte et al. surveyed coaches' attitudes towards the use of computer-based technology in executive coaching through a questionnaire to identify a correlation between a preference for a systematic coaching approach and positive opinions toward the use of a computer [45]. They suggested, however, that due to a lack of studies on computer-based coaching, it is not possible to derive implications or further use cases beyond telecoaching and online coaching platforms. They also emphasized the importance of developing such applications to establish more systematic coaching processes. Subsequently, Pascal et al. also encouraged coaching researchers and practitioners to investigate the use of computer-based technologies [48].

Recently, Arakawa and Yakura introduced REsCUE [2], a new computer-based approach to support coaches inferring a coachee's internal state during sessions. It takes behavioral data as input which can be obtained by computer vision techniques, such as human pose estimation [63]. Then, it uses an anomaly detection algorithm based on Gaussian Mixture Model [67] to detect cues that might be missed and sends a signal to the coach in real-time. The participating coaches reported that they could provide good questions in sessions that would better facilitate a coachee's reflection.

Still, there remain few studies about computer-supported approaches in executive coaching despite its high expectations. We found no proposals with relevance to video-reflection or meta-reflection exploiting emerging technologies.

HYPOTHESES

As mentioned in the "Background" section, although videoreflection is known to help review coaching sessions, existing approaches are time-consuming and highly dependent on individual skills due to a lack of systematic designs. They often must playback the entire video session to find important words or behaviors and reflect on each point manually. Therefore, in this study, we aim to elucidate how computers can support video-reflection in its efficiency and effectiveness.

We evaluate the possibility by implementing a tool designed explicitly for video-reflection that incorporates video interaction methods and human behavior analysis approaches. In the reflection process using the tool, participants are requested to classify the candidate scenes automatically detected by REs-CUE [2] as informative or not informative through an efficient user interface. Through this process, they are automatically guided to look back through the sessions to evaluate each suggested scene. As a result, they should conduct their reflection systematically without the need to play the entire coaching session as the detected scenes are expected only to include the important portions of the session. Thus, our hypothesis behind this design can be designated as follows:

H1: The computational support in video-reflection leads to a time-efficient reflection of coaching sessions.

The implemented tool also provides a chance of reflection for both the coach and coachee as well as an opportunity to discuss their opinions about each cue by utilizing the classification results. If both roles agree on the judgment, then the cue is likely to be informative or not. On the other hand, if their opinions contradict, then the cue represents a point for which the coach and coachee review differently. Since the above classification processes are executed individually without awareness of the other's decision, we expect they exchange ideas on each discrepancy without judgment. This process can induce meta-reflection through the review of one's thoughts about experiences. Here, our hypothesis behind this idea is as follows:

H2: The computational support in meta-reflection leads to a further outcome of the reflection.

If these hypotheses are supported, then they can pave the way for improving executive coaching through computer support, which will benefit society by facilitating the development of human resources. With this motivation, we evaluated these hypotheses by conducting a user study, which we present later in the "Method" section.

INWARD: A REFLECTION SUPPORT TOOL

Before explaining the procedure of our study, in this section, we describe the design and usage of our reflection support tool, INWARD.

As mentioned in the "Hypotheses" section, INWARD supports the reflection in two steps. Subsequently to the coaching session, it provides an effective and efficient video-reflection process for both the coach and coachee separately. Then, it provides the computer-facilitated meta-reflection process by evoking a discussion on the result of the video-reflection process between them.

Video-Reflection

As mentioned in the "Hypotheses" section, INWARD is based on the cues detected from the recorded video of the coaching session through a human behavior analysis algorithm [2]. It applies a GMM-based unsupervised anomaly detection algorithm to multimodal human signals such as posture and gaze data. Especially, its effectiveness in executive coaching was demonstrated empirically in their study by comparing the extracted cues with those raised by professional coaches who watched the entire video, showing its performance with relatively high recall. In other words, the cues are confirmed to capture the important scenes for understanding a coachee's internal states during the session, as mentioned in the "Computational Support in Coaching" section. Therefore, we expect the reflection can be led by reviewing the cues and looking back at the individual scenes without watching the entire video.

In INWARD, the detected cues are presented along a seek bar positioned below the video in the user interface (Figure 1A) enabling the coach and coachee to make selections easily. In addition, they can playback the video through a fast-forward (Figure 1B) while emphasizing detected cues by changing the playback speed adaptively, as proposed by Higuchi et



Figure 1. The interface of INWARD during the video-reflection process.



Figure 2. The interface of INWARD during the meta-reflection process.

al. [27]. Next, the coach and coachee are prompted to classify the scenes containing detected cues as informative or non-informative (Figure 1C). With this classification process, they can efficiently reflect through the entire coaching session. Breaks in the conversation split these scenes during the coaching session, which are estimated by a voice activity detection algorithm [52]. As the detection algorithm can miss cues that may be considered informative, we designed INWARD to allow both the coach and coachee to mark scenes not pre-detected by the algorithm.

When scenes are classified, they are also asked to enter comments through the interface (Figure 1D), which is intended for use during the consecutive post-reflection session and promoting the reflection through verbalization, as suggested by Munby [40]. After the coach and coachee finish the video-reflection process (Figure 1E), they proceed to the metareflection session.

Meta-reflection

As described in the "Methods to Realize Reflection in Coaching" section, the meta-reflection is realized by thinking about the experience. Thus, we expect that the meta-reflection can be led by exploiting the results of the video-reflection process. That is, discussing the classification results between the coach and coachee would offer a chance to review each other's thoughts from the video-reflection process.

In INWARD, we evoke such discussion by highlighting the difference in the opinions about the classified scenes (Figure 2B) while also presenting the comments each provided during the video-reflection process (Figure 2C). Then, based on this combined information, the coach and coachee are prompted to discuss their reasoning and thoughts behind until they reach a consensus.

METHOD

To investigate our hypotheses, we conducted a user study with professional coaches and their coachees using INWARD. In this section, we describe the procedure of the study including the information about the participants.

Participants

The experiment involved five volunteer professional coaches (C1–5) aged 25–40 years old and 20 coachees (P1–20) aged 23–54 years old. We first recruited the participating coaches, and then asked their clients for the participation without compensation. All pairs of the coach and coachee had conducted their first session for self-introduction and goal setting about one month before the experiment. Of course, all the participants agreed to the use of the collected data for research purposes.

We randomly divided the participating coachees into two groups of treatment (P1–10) and control (P11–20). Then, each coach held coaching and consecutive reflection sessions with two coachees from the treatment group and other two coachees from the control group. The reflection process with a coachee from the treatment group employed INWARD, whereas the control group used only the recorded video of the coaching session. The order regarding the groups were shuffled at random in each coach.

Measure

Our goal is to understand how INWARD efficiently and effectively contribute to the reflection in the field of executive coaching. Accordingly, we introduced two measurements of time and authenticity.

Measurement of Reflection Efficiency: Time

The time metric indicates how efficient the implemented tool makes the video-reflection process. The participants were asked to conduct video-reflection until they felt satisfied as described later, and the time to reach this condition was measured.

Measurement of Reflection Effectiveness: Authenticity

Several measurements for evaluating the outcome of executive coaching have been proposed in the literature. For example, Guskey introduced a five-level model of professional development evaluation [24] that included the participants' reactions to sessions (level 1), their learning (level 2), organizational support and change (level 3), their use of new knowledge and skills (level 4), and their learning outcomes (level 5). He prepared a set of questions to be addressed during each level,

which has been utilized to identify key components in executive coaching [46], for instance.

Although this measurement approach is useful to evaluate how coaching helps participants' performance within their organizations, it cannot be used in this study because our primary interest is to quantify and compare the effect of reflection, which is related to a subjective self-recognition, not specific skills. To this purpose, the previous literature has utilized self-awareness and authenticity as discussed in the "Effects of Reflection in Coaching" section.

Self-awareness is used to represent a human's ability to shift attention from the outward environment to themselves [9]. As the essence of this feature is captured through attention, it is known that self-awareness is easily induced by urging participants to care about themselves, for example, by exposing them to a full-length mirror [62]. Another example comes from a prior self-awareness scale containing subjective statements, such as "right now, I am feeling conscious of my inner feelings" [20].

On the other hand, authenticity represents the consistency among not only one's conscious awareness of an internal state but also one's primary experiment as well as outward behavior and communication [3]. Thus, the enhancement of authenticity is greatly dependent on the quality of intervention, i.e., reflection. In addition, considering that authenticity is a key factor for well-being and optimal functioning, prior work concluded that coaching-related concepts are inextricably entwined with authenticity [59].

Therefore, authenticity is used in this study to measure the efficacy of computer-supported reflection in coaching. We use the Authenticity Scale defined by Wood et al. [66], which has been widely used to evaluate psychological interventions [30]. It contains a 12-item scale designed to assess the extent of the three factors from Barrett-Lennard's definition of authenticity including self-alienation, authentic living, and accepting external influence [3]. Self-alienation represents the unavoidable discrepancy between one's actual experience (the true self) and their conscious awareness. A mismatch between them indicates that the individual goes through the experience of not knowing oneself, or feeling out of touch with the true self. Authentic living considers the extent to which an individual expresses emotions and behaves that are consistent with their awareness of internal states. Accepting external influence means the tendency of an individual to accept the influence of others, which accounts for the external effects of their social environment.

Through the Authenticity Scale, participants are required to answer each item on a seven-point Likert scale, i.e., from 1 ("does not describe me at all") to 7 ("describes me very well"). Scores estimating self-alienation and accepting external influence are reversed because they are negatively correlated with authenticity. As all the participants are Japanese, a translated version [29] of the Authenticity Scale is used in this study.

Procedure

The overview of the experimental procedure is outlined in Figure 3. The participating coaches were asked to host a typi-



Figure 3. The experimental procedure.

cal coaching session with the coachees lasting about 45 minutes and take a video with a tabletop camera. The sessions were held at the office of the coaches as their usual sessions. Following each session, we asked the coachee to complete the questionnaire form of the Authenticity Scale.

Directly after the questionnaire, the participants proceeded to the video-reflection process. For the treatment group, we provided INWARD integrated with the recorded video to both the coaches and coachees. After a brief instruction of its usage, we asked them to classify all the detected cues. For the control group, we provided only the recorded video to the coachees and asked them to reflect on the coaching session by watching the video until they were satisfied. In both groups, we asked the coachees to complete the questionnaire after the video-reflection process again.

Through this procedure, we evaluated H1 by comparing the metrics introduced in the "Measure" section between the control and treatment groups. If the authenticity of the treatment group displays an improvement better than that of the control group while the treatment group spends less time during the video-reflection process, then H1 is supported.

In addition, we also asked the coaches in the treatment group to conduct the meta-reflection process with the coachees using INWARD. We explained the functions of the interface and asked them to discuss until they had a consensus about their classifications. After the meta-reflection process, we again asked the coachees to complete the questionnaire to evaluate H2 through a comparison of authenticity. If the score of authenticity was improved after the meta-reflection process, then H2 is supported.

After completing the reflection processes, the participated coachees in the treatment group (P1–10) were given a short semi-structured interview for 10 to 15 minutes. The interview was taken place by one of the authors in the same room without the coaches so that they would not affect the responses from the coachees. We first asked for their subjective opinions about the usability of INWARD, using an open-ended question such as "how do you feel about the usability of this tool?" We then inquired about their thoughts and findings from both the video-reflection and meta-reflection processes like "how do you feel about the video-reflection process?" and "what kind of findings or learning did you have from the meta-reflection



Figure 4. The change in the score of authenticity through the video-reflection process in the control group (error bars represent standard errors). *p < 0.05, **p < 0.01, ***p < 0.001.



Figure 5. The change in the score of authenticity through the video-reflection process in the treatment group (error bars represent standard errors). n.s. – not significant, *p < 0.05.

process?" For comparison, we also asked three coachees from the control group (P11–13) about their thoughts and findings in the same manner. In addition, for the participating coaches (C1–5), we subsequently asked their opinions about INWARD, such as "where did you find the advantages and future possibilities of this tool?"

RESULTS

Efficiency and Effectiveness of Video-Reflection (H1)

Figure 4 and Figure 5 show the change in the score of authenticity calculated from the answers of the participating coachees in the control and treatment groups, respectively. In both cases, it is confirmed that the scores are significantly improved through the video-reflection process using a paired t-test.

Interestingly, the score of authentic living decreases in both cases despite the increase of the total score. This phenomenon may be attributed to that the reflection might evoke the coachees' feelings of awkwardness about their words during the coaching sessions since the questions for authentic living involve consistency with the conscious awareness, such as "I am true to myself in most situations." This is supported by the impressions from the coachees obtained during the post-study interview, such as "reviewing my words from an objective perspective reminded me that I was trying to justify myself and conceal my honest feelings (P3)."



Figure 6. The difference of the change in scores between the control and treatment groups (error bars represent standard errors). n.s. – not significant.

Table 1. The average time the participating coachees spent during the coaching session and video-reflection process (standard error in parentheses).

	Average duration		
	Coaching	Reflection	Difference
	session	process	
Treatment	47.2 min	18.8 min	-28.4 min
	(±1.6 min)	(±2.5 min)	(±2.6 min)
Control	42.7 min	45.3 min	+2.0 min
	(±1.0 min)	(±4.2 min)	(±4.8 min)

Figure 6 compares the score changes between the control and treatment groups. Using a Mann-Whitney u-test, we confirmed that the effectiveness of the video-reflection is not significantly different regardless of the use of INWARD. In other words, the coachees who used INWARD had comparable effects as the coachees who watched the video of the entire sessions.

On the other hand, the time required to conduct the videoreflection process was crucially reduced by INWARD as shown in Table 1. Whereas the coachees in the control group spent more time for the reflection than the coaching sessions, the coachees in the treatment group spent less than half of the duration for the sessions.

In addition, we found that some of the coachees in the control group spent much less time during the video-reflection process than the sessions, which is similar to the treatment group. After further investigation, we confirmed that they had experienced a similar video-reflection process before this study and fastforwarded the video as they were instructed by the coaches at that time. The fact that such a technique was independently adopted justifies the design of INWARD, which plays back the unimportant scenes of the video in the fast-forward manner.

From these results, we conclude that the video-reflection process guided by INWARD shows comparable effectiveness compared to the conventional approach while it crucially reduced the time required to conduct. In that respect, H1 is partially supported by the study, that is, the reflection process provided by the tool is more efficient but cannot be said to be more effective than watching the entire video without the assistance of tools.



Figure 7. The change in the score of authenticity through the meta-reflection process in the treatment group (error bars represent standard errors). n.s. – not significant, *p < 0.05, **p < 0.01.



Figure 8. The difference in the change of the scores between the video-reflection process of the control group and the complete process of the treatment group (error bars represent standard errors). n.s. – not significant, *p < 0.05.

Effectiveness of Meta-reflection (H2)

Figure 7 shows the change in the score of authenticity through the meta-reflection process in the treatment group. Similar to the video-reflection process, this result confirms that the metareflection process is supported by INWARD with a significant increase in the authenticity of the coachees. Therefore, as discussed in the "Procedure" section, H2 is supported by the study.

In addition, Figure 8 compares the change in the scores between the control and treatment groups and shows the effect of the reflection in the treatment group was significantly better than the control group. This suggests that such an effect would not be achieved by the conventional approach of watching the video without the support of computers. That is to say, executive coaching can be improved with computer support, such as with INWARD.

We note that the difference between the control and treatment groups could not be attributed to the difference of the time the participants spent on the reflection process. In detail, we observe the participating coachees in the treatment group spent an average of 22.6 minutes (standard error: 1.6 minutes) for the meta-reflection process excluding one outlier case, which we describe in the "How Coachees are Affected via Meta-reflection" section. In other words, combined with the results in Table 1, most spent 41.0 minutes (standard error: 2.9 minutes) for the entire reflection processes, which is not crucially different from the time the control group spent only on the video-reflection process. Therefore, we conclude that the difference in the efficacy between the control and treatment groups shown in Figure 8 is not due to the coachees in the treatment group spending more time.

User Comments

As presented above, our quantitative results showed that IN-WARD provides an effective and efficient reflection for the participating coaches. In this section, to further explore these results, we review the comments obtained during the study. Here, we aggregated the comments in correspondence to the questions we asked in the interview (the "Procedure" section) as following sections.

How Coachees are Affected via Video-Reflection

Overall, the participating coachees responded positively to the video-reflection process using INWARD. In particular, the use of the cues detected by the human behavior analysis algorithm is favored. For example, a coachee provided the following comment on its superiority in comparison to merely watching the video.

When I looked at the highlighted scenes, the outline of the session came to my mind spontaneously. So, I felt that there was no need to watch the video entirely. (P1)

Another coachee who experienced the conventional videoreflection process of watching the video offered the following comment regarding a different aspect of its advantage.

When I reflect by watching the entire video of the session, I tend to pay attention to the content of the conversation and have a little difficulty reviewing objectively. On the other hand, in this way, I felt that I can review more objectively maybe thanks for focusing on the limited parts of the sessions. (P4)

Along with other favorable comments, they support the effectiveness of the video-reflection process in INWARD.

However, at the same time, there was a comment pointing out the difficulty of judging whether the cue is informative or not.

In some situations, I wondered if I should classify as informative. For example, it was not clear about the case when the conversation topic is important but my behavioral change itself is trivial. (P9)

This comment indicates the importance of presenting a clearer explanation regarding the criteria, considering that the classification results are used later in the meta-reflection process.

Regarding authenticity, three participating coachees (P1, P3, P6) provided similar comments related to authentic living, one of which is mentioned in the "Efficiency and Effectiveness of Video-Reflection (H1)" section. Another coachee responded with the following comment regarding the factor of accepting external influence.

The most impressive scene in the video-reflection process was that I was trying to convey my standpoint to the coach with a big gesture. Looking back on my words at that time, I realized that I was quite stubborn. (P2)

On the other hand, similar comments connected to authenticity were received also from the coachees in the control group, such as "watching the video of the session, I noticed my unconscious resistive attitude (P12)." This observation corroborates the result of Figure 6, which shows there exists no significant difference between the control and treatment groups through the video-reflection process.

The following interesting comment pays attention not only to the coachee oneself but also to the coach.

By watching only the important scenes continuously, I found that the coach was consistently trying to ask only one point: "what will you do to change the situation?" Through the reflection, I realized that I was not able to grasp the true intention of the coach during the session. (P5)

Though such a reaction might not affect one's authenticity, the comment suggests a potential of further influence from the video-reflection process on the outcome of the coaching effort.

Another coachee mentioned a different aspect of the influence of the video-reflection process.

Before we had the coaching session, I was informed that the recorded video would be used for the post-reflection process, but I did not know the detail of how to use it in the tool. If I knew that beforehand, I might have been aware of my behavior during the session. (P10)

We note that such an observer effect can be induced also by the conventional video-reflection approach considering that it is aimed to introduce the objective perspective, as mentioned in the "Methods to Realize Reflection in Coaching" section. Having said that, a long-term repetitive evaluation is desirable to figure out the effect.

How Coachees are Affected via Meta-reflection

As the participating coachees commented positively to the video-reflection process, many of them mentioned the intrinsic difference with the meta-reflection process.

By discussing the difference in opinions, I understood how the coach was seeing me and was able to look back on my behavior and judgment from a totally different point of view. (P6)

Through discussions with the coach, I realized another interpretation of my movement from a different perspective. The process of the discussion itself was engaging. (P9)

In the meta-reflection process, the coach pointed out some of the cues which I classified into non-informative contain important topics which I close my eyes to unconsciously. I did not agree on the indication completely, but it is certain that I could not notice such an inclination if I had the video-reflection alone. (P3) From these comments, we interpret the efficacy of the metareflection presented in the "Effectiveness of Meta-reflection (H2)" section due mainly to the introduction of the perspective of the coach.

Regarding the advantage of conducting the meta-reflection process with computer support, the participating coachees commented as follows.

By conducting the video-reflection separately in advance and writing down the reason for the judgment, I was able to explain my thought without being influenced by the words from the coach. (P7)

I think that we had a focused and constructive discussion by narrowing down the points to discuss into a few scenes where we had different opinions. (P8)

On the other hand, as mentioned in the "Effectiveness of Metareflection (H2)" section, one coachee exhibited an outlier case that spent more than an hour on the meta-reflection with the coach although they had a 43-minute coaching session. He commented about the reason as follows.

We got heated up from the discussion of a certain scene, and the situation became as if we had another coaching session. As a result, it took quite a long time, but it was worthwhile because I was able to talk about my values and self-understanding at a deeper level than in the previous session. (P3)

This phenomenon implies that INWARD can facilitate not only the reflection but also an extended coaching session.

Usability

Partly due to the efficiency of the reflection process, the coachees replied affirmatively to the usability of INWARD.

It was totally good because I was able to conduct the reflection process just by following the steps as shown in the interface. (P1)

In particular, the fast-forwarding playback was favorably received as expressed in the following comment.

I appreciate the automatic adjustment of the playback speed because it enables me to grasp the outline of the session in a short time. If I skipped the scenes other than the detected ones, I might feel like I missed some important scenes. (P2)

On the other hand, the functionality to mark scenes not containing detected cues as informative was rarely used. One coachee suggested the reason was as follows.

In the process of classifying the detected scenes, I was satisfied that I had enough reflection, and thus, I did not feel the need to mark additionally. (P4)

Another coachee offered an addition of a function to improve usability.

Sometimes when I moved to the next cue, the timing of the conversation was halfway and I could not immediately understand the ongoing topic. I think that it is easier to use if this system automatically displays the transcription in synchronization with the video. (P10)

These comments suggests there is room for further improvement in the interface and interaction of INWARD.

Further Possibilities for Computer-Supported Coaching

As described in the "Procedure" section, we also obtained comments also from the participating coaches, which suggest further possibilities for utilizing computer-supported tools in executive coaching. For example, one coach pointed out that the meta-reflection process could also contribute to the improvement of the coach's skill.

In a regular coaching session, there is seldom a direct feedback from a coachee about my judgment. Though self-understanding of the coachee is often biased unconsciously, I think that discussions like I had in the meta-reflection process give us a chance to gain a new perspective as a coach. (C5)

In terms of helping coaches develop their skills, another coach suggested using INWARD in supervision.

If the cues are detected based on the behavior of coaches, I expect that we can reflect our coaching skills efficiently in the same way. In addition, I often watch videos of coaching sessions by new coaches to give feedback. I think that the same approach also works for such cases. (C1)

As pointed out here, we expect that the approach of INWARD, efficiently reviewing the video of coaching sessions, can be applied for further use cases.

In addition, there was a request of new feature to composite summary video of the session.

In most cases, we have a session about a month after the previous session, so I feel it is a little difficult to remember what we said in the last time. If we have a summarized video in the same manner as the videoreflection process, it would be helpful for us. (C3)

Considering that we can obtain the classification result that both the coach and coachee agreed on through the reflection processes, such a summarized video could be easily generated by leveraging INWARD.

DISCUSSION

So far we presented that video-reflection in executive coaching can be improved through a computer-supported approach. In this section, we contemplate the implications of these findings and discuss its relevance to existing studies about reflection in the workplace to position our work within the HCI community.

Implications for Facilitating Reflection Using Computers

Necessity of Meta-reflection after Video-Reflection

Through the measurement of the participants' authenticity in the proposed reflection processes, our study depicts the effect of the reflection on participants at each stage precisely. We note that the effect of such a multistage reflection is not fully discussed after the original proposal [60]. Our analysis across two stages of the video-reflection and meta-reflection processes that considers three factors of the authenticity sheds light on this point.

A unique finding of the video-reflection process is that participants tend to decrease their authentic living score, as we mentioned in the "Efficiency and Effectiveness of Video-Reflection (H1)" section and the "How Coachees are Affected via Video-Reflection" section. This phenomenon can be explained by their gaining an objective perspective through self-observation of the session using such an individual video-reflection process. They then likely notice discrepancies between their outward expression and internal states. This result is more interesting as the score is significantly ameliorated through the meta-reflection process, as shown in Figure 7, which indicates the collaborative discussion provides a new perspective for a coachee to understand themselves better. From these points, although a further investigation with more participants is needed to verify our finding, it would be recommended that coaches actively provide opportunities to exchange views on what makes coachees feel awkward or find inconsistencies regarding their behavior.

Effectiveness of Providing Grounds for Discussion by Computers

In INWARD, the coaches and coachees first reflect individually on candidate scenes that are automatically detected before exchanging opinions about scenes they judge differently. As presented in the "How Coachees are Affected via Meta-reflection" section, some coachees offered favorable comments on this design because the precedent individual reflection enabled their judgment to be independent of the coaches' perspectives, which can lead to a constructive discussion during the meta-reflection process.

This result aligns with the design of *collaborative reflection* that first requires reflective writing so as to discuss topics with peers [49, 68, 50]. Through experiments involving colleague physicians [50] or teachers [49, 68], collaborative reflection is demonstrated to provide opportunities to deepen their reflection

However, the direct application of collaborative reflection in executive coaching would reduce the impact of its outcome because its framework allows for the topics for discussion to be filtered by the coachee. As one coach commented in the "Further Possibilities for Computer-Supported Coaching" section, the result of the individual video-reflection can be biased. In fact, we found that 18.4% of the cues marked as important by the coaches were disregarded by the participating coachees. Considering this result, discussion on these cues would not have occurred from the standard procedure of collaborative reflection.

Therefore, we believe that INWARD contributes to deepening the reflection by providing grounds for discussion using automatically detected cues. This result is also supported by the participating coachee's comment (P3) quoted in the "How Coachees are Affected via Meta-reflection" section that suggests an unconscious bias. This experience implies that providing grounds for discussion by computers can enhance the effect of collaborative reflection.

Relevance to Prior Studies Facilitating Reflection at Work

The literature in the HCI community have seen quite a few studies on technologies and designs supporting reflection for the purpose of learning from experiences [4, 5, 16, 43, 57]. Some of them featured computer-supported tools for fostering reflection at work due to the increasing need for workplace learning as a crucial mean for employees to keep their skills and knowledge up-to-date. For example, Prilla et al. conducted a case study to elucidate a design for tools to support collaborative reflection in a healthcare workplace [50]. Subsequently, Prilla and Renner introduced a reflection-sharing app in four workspaces to evaluate socio-technical aspects of such tools [51]. Fessl et al. discussed the function of computerbased reflection guidance through trials at four workplaces [15]. Here, these studies aimed to increase reflection opportunities at the workspace, as the metrics they used are based on the number of app usages.

We agree on the importance of guiding users to have more reflection opportunities, but the depth of reflection is simultaneously no less essential. In other words, when more people are motivated for reflective learning at work through these studies, there will be a demand to deepen the learning process of each reflection. In this respect, our results suggest how technology can amplify the effect of reflection with a consideration of internal changes.

In a similar context, Renner et al. analyzed existing methods for computer-supported reflective learning [53] by aggregating data obtained from 20 field studies with 12 applications to understand workers' reactions to apps, effects of reflective learning, effects on working behavior, and impacts on organizations. While this study reveals a good systematic framework for introducing reflection support tools at the workplace, it lacks a detailed analysis on which part of the applications increased the outcome of reflection and how.

Here, INWARD is specifically designed for improving the effectiveness, and the obtained results confirmed that the combination of video-reflection and meta-reflection significantly increased the participants' authenticity. We expect that, by integrating with emerging technologies, the outcome of reflection can be further deepened through a computer-supported approach. Based on this above discussion, more studies on promoting reflections at the workplace are desired to meet the demand for workplace learning.

LIMITATIONS AND FUTURE WORK

Some limitations exist in this study. First, the interaction through the interfaces of INWARD is not fully sophisticated, and we cannot rule out the possibility that this affected the results. Specifically, as described in the "Usability" section, the participants did not try to find scenes other than what the behavior analysis algorithm detected, for instance. To eliminate such a possibility and further support our hypotheses, future work will feature additional experiments with a greater number of participants, which would be also helpful to understand the observer effect mentioned in the "How Coachees are Affected via Video-Reflection" section.

In addition, we would like to explore further use cases of INWARD, as pointed out in the "Further Possibilities for Computer-Supported Coaching" section, along with other application scenarios outside of executive coaching. For example, recent studies proposed computer-supported training systems for improving interpersonal skills in social interactions, such as job interviews [28] or counselling [41]. Considering that such practice sessions involve the video-reflection process, such systems can be enhanced by harnessing INWARD to reflect on their unconscious behaviors efficiently.

CONCLUSIONS

In this paper, we examined the possibility of evolving the video-reflection process for executive coaching into an effective and efficient approach by providing our computer-based supporting tool INWARD. This tool presents important scenes from the sessions, which are detected by a human behavior analysis algorithm, so that the coachee can reflect facilely by reviewing through the video-interaction technique. In addition, it offers an opportunity for meta-reflection by facilitating discussions with the coach during the reflection process. The results of our user study showed that INWARD successfully reduces the time of video-reflection and improves an individual's authenticity via the entire reflection process. These findings support our hypotheses while opening opportunities to utilize computers further to assist coaching in benefiting the field of human resource development.

REFERENCES

- Jagdishkumar Aggarwal and Michael S. Ryoo. 2011. Human activity analysis: A review. *Comput. Surveys* 43, 3 (2011), 16:1–16:43. DOI: http://dx.doi.org/10.1145/1922649.1922653
- [2] Riku Arakawa and Hiromu Yakura. 2019. RESCUE: A framework for REal-time feedback on behavioral CUEs using multimodal anomaly detection. In *Proceedings of the 2019 ACM CHI Conference on Human Factors in Computing Systems*. ACM, New York, NY, Article 572, 13 pages. DOI:

http://dx.doi.org/10.1145/3290605.3300802

- [3] Godfrey T Barrett-Lennard. 1999. *Carl Rogers' Helping System: Journey and Substance*. SAGE Publications, London UK.
- [4] Eric P. S. Baumer. 2015. Reflective Informatics: Conceptual Dimensions for Designing Technologies of Reflection. In *Proceedings of the 2015 ACM CHI Conference on Human Factors in Computing Systems*. ACM, New York, NY, 585–594. DOI: http://dx.doi.org/10.1145/2702123.2702234
- [5] Eric P. S. Baumer, Vera D. Khovanskaya, Mark Matthews, Lindsay Reynolds, Victoria Schwanda Sosik, and Geri Gay. 2014. Reviewing reflection: on the use of reflection in interactive system design. In *Proceedings of* the 2014 ACM Conference on Designing Interactive

Systems. ACM, New York, NY, 93–102. DOI: http://dx.doi.org/10.1145/2598510.2598598

- [6] Ian Brooks and Sarah Wright. 2007. A survey of executive coaching practices in New Zealand. *International Journal of Evidence Based Coaching and Mentoring* 5, 1 (2007), 30–41.
- [7] Lynn A Bryan and Art Recesso. 2006. Promoting reflection among science student teachers using a web-based video analysis tool. *Journal of Computing in Teacher Education* 23, 1 (2006), 31–39. DOI: http://dx.doi.org/10.1080/10402454.2006.10784557
- [8] Fraser Carson. 2008. Utilizing video to facilitate reflective practice: Developing sports coaches. *International Journal of Sports Science & Coaching* 3, 3 (2008), 381–390. DOI: http://dx.doi.org/10.1260/174795408786238515
- [9] Charles Horton Cooley. 1902. *Human nature and the social order*. Charles Scribner's Sons, New York, NY.
- [10] Erik De Haan. 2012. Supervision in Action: A relational approach to coaching and consulting supervision. Open University Press, New York, NY.
- [11] John Dewey. 1933. *How we think: a restatement of the relation of reflective thinking to the educative process.* Houghton Mifflin, Boston, MA.
- [12] Shelley Duval and Robert A Wicklund. 1972. A theory of objective self awareness. Academic Press, Oxford, UK.
- [13] Daniel C. Feldman and Melenie J. Lankau. 2005.
 Executive Coaching: A Review and Agenda for Future Research. *Journal of Management* 31, 6 (2005), 829–848. DOI: http://dx.doi.org/10.1177/0149206305279599
- [14] Allan Fenigstein, Michael F Scheier, and Arnold H Buss.
 1975. Public and private self-consciousness: Assessment and theory. *Journal of Consulting and Clinical Psychology* 43, 4 (1975), 522–527. DOI: http://dx.doi.org/10.1037/h0076760
- [15] Angela Fessl, Gudrun Wesiak, Verónica Rivera-Pelayo, Sandra Feyertag, and Viktoria Pammer. 2017. In-app reflection guidance: lessons learned across four field trials at the workplace. *IEEE Transactions on Learning Technologies* 10, 4 (2017), 488–501. DOI: http://dx.doi.org/10.1109/TLT.2017.2708097
- [16] Rowanne Fleck and Geraldine Fitzpatrick. 2010.
 Reflecting on reflection: framing a design landscape. In Proceedings of the 22nd Australasian Computer-Human Interaction Conference. ACM, New York, NY, 216–223.
 DOI:http://dx.doi.org/10.1145/1952222.1952269
- [17] Margaret A. Fletcher, Ortrun Zuber-Skerritt, Brendan Bartlett, Ruth Albertyn, and Judith Kearney. 2010.
 Meta-Action Research on a Leadership Development Program: A Process Model for Life-long Learning. Systemic Practice and Action Research 23, 6 (2010), 487–507. DOI:

http://dx.doi.org/10.1007/s11213-010-9173-5

- [18] Ricki Goldman, Roy Pea, Brigid Barron, and Sharon J Derry. 2014. Video research in the learning sciences. Routledge, London, UK.
- [19] Daniel Goleman. 1995. *Emotional intelligence*. Bantam, New York, NY.
- [20] John M Govern and Lisa A Marsch. 2001. Development and validation of the situational self-awareness scale. *Consciousness and cognition* 10, 3 (2001), 366–378. DOI:http://dx.doi.org/10.1006/ccog.2001.0506
- [21] Stella Granville and Laura Dison. 2005. Thinking about thinking: Integrating self-reflection into an academic literacy course. *Journal of English for Academic Purposes* 4, 2 (2005), 99–118. DOI: http://dx.doi.org/10.1016/j.jeap.2004.07.009
- [22] David E Gray. 2006. Executive coaching: Towards a dynamic alliance of psychotherapy and transformative learning processes. *Management learning* 37, 4 (2006), 475–497. DOI:
 - http://dx.doi.org/10.1177/1350507606070221
- [23] Ryan Groom and Chris Cushion. 2005. Using of video based coaching with players: A case study. *International Journal of Performance Analysis in Sport* 5, 3 (2005), 40–46. DOI:

```
http://dx.doi.org/10.1080/24748668.2005.11868336
```

- [24] Thomas R Guskey. 2000. *Evaluating professional development*. Corwin Press, Thousand Oaks, CA.
- [25] Neville Hatton and David Smith. 1995. Reflection in teacher education: Towards definition and implementation. *Teaching and Teacher Education* 11, 1 (1995), 33–49. DOI: http://dx.doi.org/10.1016/0742-051X(94)00012-U
- [26] Peter Hawkins. 2014. Coaching supervision. In *The Complete Handbook of Coaching* (2 ed.), Elaine Cox, Tatiana Bachkirova, and David Clutterbuck (Eds.). SAGE Publications, London, UK, 381–393.
- [27] Keita Higuchi, Ryo Yonetani, and Yoichi Sato. 2017. EgoScanning: Quickly Scanning First-Person Videos with Egocentric Elastic Timelines. In Proceedings of the 2017 ACM CHI Conference on Human Factors in Computing Systems. ACM, New York, NY, 6536–6546. DOI:http://dx.doi.org/10.1145/3025453.3025821
- [28] Mohammed (Ehsan) Hoque, Matthieu Courgeon, Jean-Claude Martin, Bilge Mutlu, and Rosalind W. Picard. 2013. MACH: my automated conversation coach. In Proceedings of the 2013 ACM International Joint Conference on Pervasive and Ubiquitous Computing. ACM, New York, NY, 697–706. DOI: http://dx.doi.org/10.1145/2493432.2493502
- [29] Kiyoko Ishikawa, Tsugukazu Sugahara, Chihiro Kabe, and Ryota Negishi. 2014. The Development of a Japanese Authenticity Scale: Research on the Authentic Personality Development (in Japanese). In *Proceedings* of the 78th Annual Convention of the Japanese Psychological Association. Japanese Psychological Association, Tokyo, Japan, 1EV–2–024.

- [30] Evan Kalkus. 2018. The reality-machine: development of a thought experiment measure for potential use with psychotherapy clients. Ph.D. Dissertation. Graduate School of Applied and Professional Psychology, Rutgers University.
- [31] Michael H Kernis. 2003. Toward a conceptualization of optimal self-esteem. *Psychological Inquiry* 14, 1 (2003), 1–26. DOI: http://dx.doi.org/10.1207/S15327965PLI1401_01
- [32] Richard R Kilburg. 1997. Coaching and executive character: Core problems and basic approaches. *Consulting Psychology Journal: Practice and Research* 49, 4 (1997), 281–299. DOI: http://dx.doi.org/10.1037/1061-4087.49.4.281
- [33] Francis A Kombarakaran, Julia A Yang, Mila N Baker, and Pauline B Fernandes. 2008. Executive coaching: it works! *Consulting Psychology Journal: Practice and Research* 60, 1 (2008), 78–90. DOI: http://dx.doi.org/10.1037/1065-9293.60.1.78
- [34] Richard Koonce. 1994. One on One. *Training & Development* 48, 2 (1994), 34–40.
- [35] Louise Kovacs and Sarah Corrie. 2017. Building reflective capability to enhance coaching practice. *Coaching Psychologist* 13, 1 (2017), 4–12.
- [36] Karren Kowalski and Colleen Casper. 2007. The Coaching Process: An Effective Tool for Professional Development. Nursing Administration Quarterly 31, 2 (2007), 171–179. DOI: http://dx.doi.org/10.1097/01.NAQ.0000264867.73873.1a
 - 71 Äli Laijan Inaka Lam Ljashath Wildschut D Dobart Is
- [37] Äli Leijen, Ineke Lam, Liesbeth Wildschut, P Robert-Jan Simons, and Wilfried Admiraal. 2009. Streaming video to enhance students' reflection in dance education. *Computers & Education* 52, 1 (2009), 169–176. DOI: http://dx.doi.org/10.1016/j.compedu.2008.07.010
- [38] Anastassia McNulty and Bojan Lazarevic. 2012. Best Practices in Using Video Technology to Promote Second Language Acquisition. *Teaching English with Technology* 12, 3 (2012), 49–61.
- [39] Jennifer A Moon. 2013. Reflection in learning and professional development: Theory and practice. Routledge, London, UK. DOI: http://dx.doi.org/10.4324/9780203822296
- [40] Hugh Munby. 1989. Reflection-in-Action and Reflection-on-Action. *Education and Culture* 9, 1 (1989), 31–41.
- [41] David Murphy, Petr Slovak, Anja Thieme, Dan Jackson, Patrick Olivier, and Geraldine Fitzpatrick. 2017. Developing technology to enhance learning interpersonal skills in counsellor education. *British Journal of Guidance & Counselling* 47, 3 (2017), 328–341. DOI: http://dx.doi.org/10.1080/03069885.2017.1377337
- [42] Michael Newman. 1994. *Defining the Enemy: Adult Education in Social Action*. Stewart Victor Publishing, Sydney, Australia.

- [43] Thomas Olsson, Kaisa Väänänen-Vainio-Mattila, Timo Saari, Andrés Lucero, and Juha Arrasvuori. 2013. Reflections on experience-driven design: a case study on designing for playful experiences. In Proceedings of the 6th International Conference on Designing Pleasurable Products and Interfaces. ACM, New York, NY, 165–174. DOI:http://dx.doi.org/10.1145/2513506.2513524
- [44] Ruth L. Orenstein. 2002. Executive Coaching: It's Not Just about the Executive. *The Journal of Applied Behavioral Science* 38, 3 (2002), 355–374. DOI: http://dx.doi.org/10.1177/0021886302038003006
- [45] Sebastian Otte, Adrian Bangerter, Mirjam Britsch, and Urs Wüthrich. 2014. Attitudes of coaches towards the use of computer-based technology in coaching. *Consulting Psychology Journal: Practice and Research* 66, 1 (2014), 38–52. DOI: http://dx.doi.org/10.1037/a0035592
- [46] Helen Paige. 2002. Examining the effectiveness of executive coaching on executives. *International Education Journal* 3, 2 (2002), 61–70.
- [47] Ann Watts Pailliotet. 1995. I never saw that before: A deeper view of video analysis in teacher education. *The Teacher Educator* 31, 2 (1995), 138–156. DOI: http://dx.doi.org/10.1080/08878739509555107
- [48] Alex Pascal, Maggie Sass, and Jane Brodie Gregory. 2015. I'm only human: The role of technology in coaching. *Consulting Psychology Journal: Practice and Research* 67, 2 (2015), 100–109. DOI: http://dx.doi.org/10.1037/cpb0000025
- [49] Deborah Peel and Sue Shortland. 2004. Student teacher collaborative reflection: perspectives on learning together. *Innovations in Education and Teaching International* 41, 1 (2004), 49–58. DOI: http://dx.doi.org/10.1080/1470329032000172711
- [50] Michael Prilla, Martin Degeling, and Thomas Herrmann. 2012. Collaborative reflection at work: supporting informal learning at a healthcare workplace. In *Proceedings of the 17th ACM International Conference* on Supporting Group Work. ACM, New York, NY, 55–64. DOI:http://dx.doi.org/10.1145/2389176.2389185
- [51] Michael Prilla and Bettina Renner. 2014. Supporting collaborative reflection at work: A comparative case analysis. In *Proceedings of the 18th International Conference on Supporting Group Work*. ACM, New York, NY, 182–193. DOI: http://dx.doi.org/10.1145/2660398.2660400
- [52] Javier Ramirez, Juan Manuel Górriz, and José Carlos Segura. 2007. Voice activity detection. fundamentals and speech recognition system robustness. In *Robust speech recognition and understanding*, Michael Grimm and Kristian Kroschel (Eds.). InTech, London, UK.

- [53] Bettina Renner, Gudrun Wesiak, Viktoria Pammer-Schindler, Michael Prilla, Lars Müller, Dalia Morosini, Simone Mora, Nils Faltin, and Ulrike Cress. 2019. Computer-supported reflective learning: how apps can foster reflection at work. *Behaviour & Information Technology* 0, 0 (2019), 1–21. DOI: http://dx.doi.org/10.1080/0144929X.2019.1595726
- [54] Peter J Rich and Michael Hannafin. 2009. Video annotation tools: Technologies to scaffold, structure, and transform teacher reflection. *Journal of Teacher Education* 60, 1 (2009), 52–67. DOI: http://dx.doi.org/10.1177/0022487108328486
- [55] Donald A. Schön. 1983. *The Reflective Practitioner: How Professionals Think in Action*. Basic Books, New York, NY.
- [56] Stratford Sherman and Alyssa Freas. 2004. The Wild West of Executive Coaching. *Harvard Business Review* 82, 11 (2004), 82–90.
- [57] Petr Slovák, Christopher Frauenberger, and Geraldine Fitzpatrick. 2017. Reflective Practicum: A Framework of Sensitising Concepts to Design for Transformative Reflection. In Proceedings of the 2017 ACM CHI Conference on Human Factors in Computing Systems. ACM, New York, NY, 2696–2707. DOI: http://dx.doi.org/10.1145/3025453.3025516
- [58] Lewis R Stern. 2004. Executive coaching: A working definition. Consulting Psychology Journal: Practice and Research 56, 3 (2004), 154–162. DOI: http://dx.doi.org/10.1037/1065-9293.56.3.154
- [59] Ingo Susing. 2011. The potential use of the Authenticity Scale as an outcome measure in executive coaching. *The Coaching Psychologist* 7 (2011), 16–25.
- [60] Anthony Thorpe and Diane Garside. 2017. (Co) meta-reflection as a method for the professional development of academic middle leaders in higher education. *Management in Education* 31, 3 (2017), 111–117. DOI: http://dx.doi.org/10.1177/0892020617711195
- [61] Alessandro Vinciarelli, Maja Pantic, Dirk Heylen, Catherine Pelachaud, Isabella Poggi, Francesca D'Errico, and Marc Schröder. 2012. Bridging the Gap between Social Animal and Unsocial Machine: A Survey of Social Signal Processing. *IEEE Transaction* on Affective Computing 3, 1 (2012), 69–87. DOI: http://dx.doi.org/10.1109/T-AFFC.2011.27
- [62] William M Webb, Kerry L Marsh, William Schneiderman, and Bob Davis. 1989. Interaction

between self-monitoring and manipulated states of self-awareness. *Journal of Personality and Social Psychology* 56, 1 (1989), 70–80. DOI: http://dx.doi.org/10.1037/0022-3514.56.1.70

- [63] Shih-En Wei, Varun Ramakrishna, Takeo Kanade, and Yaser Sheikh. 2016. Convolutional Pose Machines. In Proceedings of the 29th IEEE Conference on Computer Vision and Pattern Recognition. IEEE Computer Society, Washington, DC, 4724–4732. DOI: http://dx.doi.org/10.1109/CVPR.2016.511
- [64] Robert A Wicklund. 1975. Objective self-awareness. *Advances in experimental social psychology* 8 (1975), 233–275.
- [65] Robert Witherspoon and Randall P White. 1996. Executive coaching: A continuum of roles. *Consulting Psychology Journal: Practice and Research* 48, 2 (1996), 124–133. DOI: http://dx.doi.org/10.1037/1061-4087.48.2.124
- [66] Alex M Wood, P Alex Linley, John Maltby, Michael Baliousis, and Stephen Joseph. 2008. The authentic personality: A theoretical and empirical conceptualization and the development of the Authenticity Scale. *Journal of Counseling Psychology* 55, 3 (2008), 385–399. DOI: http://dx.doi.org/10.1037/0022-0167.55.3.385
- [67] Kenji Yamanishi, Jun'ichi Takeuchi, Graham J. Williams, and Peter Milne. 2004. On-Line Unsupervised Outlier Detection Using Finite Mixtures with Discounting Learning Algorithms. *Data Mining and Knowledge Discovery* 8, 3 (2004), 275–300. DOI: http://dx.doi.org/10.1023/B:DAMI.0000023676.72185.7c
- [68] Hye-Gyoung Yoon and Mijung Kim. 2010.
 Collaborative Reflection through Dilemma Cases of Science Practical Work during Practicum. *International Journal of Science Education* 32, 3 (2010), 283–301.
 DOI:http://dx.doi.org/10.1080/09500690802516538
- [69] Barry J Zimmerman. 2002. Becoming a self-regulated learner: An overview. *Theory Into Practice* 41, 2 (2002), 64–70. DOI: http://dx.doi.org/10.1207/s15430421tip4102_2
- [70] Barry J Zimmerman. 2013. Theories of self-regulated learning and academic achievement: An overview and analysis. In *Self-regulated learning and academic achievement*, Dale H. Schunk Barry J. Zimmerman (Ed.). Routledge, London, UK, 10–45.