PERFLECT

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PERFLECT: Design and Evaluation of an Electronic Development Portfolio Aimed at Supporting Self-Directed Learning

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Abstract

This design case describes the blueprints of an electronic development portfolio (PERFLECT) aimed at supporting the development of self-directed learning skills, including self-assessment of performance on learning tasks, formulation of points for improvement and future learning task selection. The design is described both in terms of theoretical foundation and practical characteristics. As part of the design process a small-scale evaluation study with 22 students of senior vocational education was conducted. Students hold positive perceptions about PERFLECT's ability to help them self-assess their performance on learning tasks and formulate points for improvement. Furthermore, they were also satisfied with PERFLECT's usability and user-friendliness. However, students request a simplification of language use and need more support and guidance with the selection of criteria for performance assessment. Suggestions for improvement will be incorporated in the next iteration of the design. PERFLECT is a promising, user-friendly tool to support students' development of SDL skills.

Keywords Self-directed learning · Electronic development portfolio · Second-order scaffolding · Educational technology

Competency-based education can have positive effects on students' motivation and the development of their domain-specific skills (Corbalan et al. 2009). Furthermore, it can also positively impact the development of self-directed learning (SDL) skills, but only when teachers devote a large amount of time and effort to coaching their students (Kicken et al. 2008). Intensive teacher guidance is required to ensure that students adequately develop SDL skills, including self-assessment of performance on learning tasks, formulation of points for improvement (PFIs), and selection of future learning tasks. SDL is not a well-defined concept. It refers to various learning processes related to self-initiated, autonomous learning. Whereas a plethora of different SDL definitions exist, most of them include some form of self-assessment, learning-needs diagnosis and formulation of learning goals, and selection of learning tasks (e.g., Caffarella 1993; Candy 1991; Mezirow 1985). It is becoming increasingly important

to develop SDL skills, because they are essential for lifelong learning (Bolhuis 2003). One way to support the development of SDL skills is by using an electronic development portfolio.

Much like SDL, portfolios can be described various classifications and typologies (e.g., Paulson and Paulson 1994; Zeichner and Wray 2001). While a golden standard does not exist, most classifications and typologies include purpose as a defining factor. Zubizarreta (2009) even argues that purpose should be the driving force behind portfolio design. The primary purpose of development portfolios as the name readily suggests, is to facilitate students' development of certain skills. Because of this, development portfolios often differ structurally and esthetically from other types of portfolios. Consider for example a showcase portfolio. This is a type of portfolio commonly used by artists to display their work. It has features to support display of artistry (e.g., the portfolio is durable to protect physical contents that need to be in pristine condition when presented). A development portfolio on the other hand, is less aimed at safeguarding physical integrity of its contents and more so on its value for reflection. This has implications for the structure of a development portfolio (e.g., it facilitates charting of learning-task performance over time). While portfolio purpose impacts portfolio design and type it not to say that actual portfolio usage occurs in a pigeonholed fashion. In practice, portfolios may be used for several purposes simultaneously (Heeneman and Driessen 2017). In short

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it can be said that 1) portfolio usage may occur in a multi-purposed fashion, 2) portfolio purpose may be very useful in differentiating between the various types of portfolios, and 3) portfolio purpose influences portfolio design.

As the purpose of development portfolios is to optimally support students' development of certain skills, the portfolio design should support this. When development portfolios are used within the context of holistic, competency-based programs which may require a high degree of learner control their design can be informed by the critically acclaimed four-component instructional design model (4C/ID; Van Merriënboer 1997). Specifically, the model suggests that electronic development portfolios should facilitate a gradual transition of responsibility for developing SDL skills from student to teacher. This process bears much resemblance to instructional scaffolding, which is aimed at facilitating a gradual transition of responsibility for developing domain-specific skills from teacher to student (e.g., Van de Pol et al. 2010). SDL skills are sometimes characterized as second-order skills. Facilitating a gradual transition of responsibility for developing these skills is referred to as second-order scaffolding (Van Merriënboer and Kirschner 2017). The 4C/ID model provides valuable guidelines to design electronic development portfolios aimed at supporting the development of SDL skills through second-order scaffolding. These guidelines have already been applied successfully in previous research which reports positive effects on the development of SDL. These effects include increases in Pfl-formulation skills and learning-task selection skills (e.g., Fastré et al. 2010; Kicken et al. 2009a, b).

While previous research has demonstrated that electronic development portfolios can be used to support the development of SDL skills, there is room for improvement. As it stands, teachers still need to invest much in terms of energy and time. Therefore, an electronic development portfolio that can effectively reduce the demands placed on teachers is needed.

Following, the design and small-scale evaluation of an electronic development portfolio (PERFLECT) are described. The name of the portfolio originates from amalgamating perfect and reflect. The name thus reflects striving for perfection through reflection. PERFLECT is aimed at supporting the development of SDL skills. In contrast with other portfolios, PERFLECT aims to do so with limited teacher coaching. PERFLECT's design is informed by the 4C/ID model, similar development portfolios, and research on effective acquisition of SDL skills with electronic portfolios (for a comprehensive overview of influencing factors, see Beckers et al. 2016). Ensuing, we will describe PERFLECT's theoretical foundation, its design, and a small-scale evaluation study.

The Design of PERFLECT

The first way PERFLECT supports the development of SDL skills, is by facilitating self-assessment of performance on learning tasks. Self-assessment comprises a four-step process in PERFLECT: 1) giving a task description, 2) selecting assessment criteria, 3) self-assessing performance, and 4) answering leading questions. First, students are asked to provide basic information about the learning task they want to assess, including the name of the learning task, the date of execution, the level of received support, and the environment in which the task was executed. Additionally, students have the ability to upload task-related materials, such as documents they used or photographs they took. Second, students are asked to select the relevant assessment criteria for the learning task. These criteria are derived from “qualification dossiers” that describe all relevant assessment criteria on three different levels of specificity (for extensive information about qualification dossiers, please see Van der Sanden et al. 2012). At the most abstract level, “core tasks” describe units of assessment very broadly. These core tasks are somewhat similar to competencies. For example, one core task in an educational program for store managers is “You carry out company policy”. At the intermediate level, “working processes” describe all constituents of the core tasks (e.g., “You analyze and interpret sales numbers”). At the most concrete level, “performance criteria” describe all constituents of the working processes (e.g., “You explain the difference between predicted and actual sales numbers”). In Fig. 1 the selection of assessment criteria is depicted. This figure shows two core tasks and their associated working processes. The associated working processes are depicted directly under the core tasks. Students can select as many core tasks and working processes for assessment as they deem relevant. This is done by placing a check in the adjacent check-box. In Fig. 1 the working process “You manage article presentations” is selected. Please note that students need not select performance criteria for assessment. Performance criteria are automatically generated when students select core tasks and working processes.

In the third step of the process students self-assess their performance on criteria that are generated from their previous selection of core tasks and working processes. Figure 2 shows the third step of the assessment process. The student is expected to score each individual criterion by selecting either U (unsatisfactory), Q (questionable), S (satisfactory), W (well), or N/A (not applicable). Finally, in the fourth step of the self-assessment process, students are presented with a self-coaching protocol. This protocol consists of eight leading questions that are designed to emulate a coaching role. Four questions in the protocol are aimed at training self-assessment skills (e.g., “What went well?”). Two questions are aimed at training formulation of Pfls (e.g., “What do you need to improve on?”). Finally, two questions are aimed at training the

Fig. 1 A screen-shot of the assessment criteria selection page. Here students select the relevant assessment criteria for their self-assessment. Students can select core tasks and working processes. Performance

criteria are automatically retrieved from these choices and shown on the subsequent page (see Fig. 2)

ability to identify learning resources that help students improve their performance on future learning tasks (e.g., “What information do you need to realize your Pfls?”).

To facilitate a gradual transition from teacher-directed learning to student-directed learning, students should share responsibility for performance assessment with their teacher or another intelligent agent when they start to acquire SDL skills (Van Merriënboer and Kirschner 2017). PERFLECT

facilitates this sharing of responsibility for performance assessment in four ways. First, learning tasks can be assessed by various assessors (i.e., the teacher, a peer student, and other relevant assessors). The availability of multiple assessments allows students to compare assessments on similarities and discrepancies. The student can access this information in assessment overviews that automatically integrate all assessment sources. Second, students can retrieve assessment

Fig. 2 A screenshot of the third step in the self-assessment process. In this step, students score performance criteria based on their previous selection of assessment criteria. They can score their performance on the listed

performance criteria with a *U*(Unsatisfactory), *Q*(Questionable), *S*(Satisfactory), *W*(Well) or *N/A* (Not applicable)

information on all levels of specificity in PERFLECT, ranging from all scores on a specific performance criterion (i.e., vertical assessments) to integrated scores on whole core tasks (i.e., horizontal assessments). They can thus access specific assessment information when they start to acquire a skill and more general information when they become more proficient at it.

A third way responsibility for performance assessment is shared, is by the implementation of coaching sessions into the PERFLECT work-flow. These sessions have been found very beneficial, if not essential to the development of SDL skills (e.g., Dannefer and Prayson 2013; Kicken et al. 2008; Van Schaik et al. 2013). In these sessions, teachers systematically discuss the assessed learning tasks with the student in the light of acquiring SDL skills. For the self-assessment part they discuss similarities and differences between their own choices of assessment criteria and scores and those of their student. Whereas these sessions start out as being teacher directed, gradually the student is expected to assume more responsibility over the learning process (see Hadwin et al. 2005). Finally, in addition to quantitative feedback, students can also access qualitative feedback in PERFLECT. This feedback is provided by the teacher after a coaching session. As students become more proficient at the various skills, the associated feedback will gradually become more global to ensure a shift in responsibility for learning.

The second way PERFLECT supports the development of SDL skills is by helping students to formulate of Pfls. This functionality is integrated in PERFLECT and the associated coaching sessions. The groundwork is laid in PERFLECT, where Pfls are automatically recorded in the final step of the self-assessment process. These recorded Pfls are also automatically integrated into the assessment overview. Subsequently, the quality of formulated Pfls is discussed in the coaching sessions. To exemplify this process, consider the following situation: A store manager trainee poorly manages customers' complaints and many customers feel they are not taken seriously. The student wants to improve his complaint-management skills and formulates the following Pfl in PERFLECT: "I need to handle complaints better". This Pfl is poorly formulated and needs to be ameliorated. To do so, the teacher focuses on four different aspects. First, specificity is targeted by focusing on the actual problem. A more specific Pfl could be: "I will show customers that I take their complaints seriously". Second, the student is coached to make the Pfl measurable, for example: "I will show customers that I take their complaints seriously, by ending every conversation with the question: Have I handled your complaint satisfactory?". Third, the teacher will coach the student to form realistic Pfls. In this case, the change from never asking customers if they are satisfied, to asking it every time, is likely to be too drastic and thus fail. A more realistic goal would be to do it 50% of the time. Finally, a well-formulated Pfl is placed in a specific time-frame. When all suggestions are

combined, the final Pfl could be: "Over the course of the next week I will show customers that I take their complaints seriously by ending at least 50% of the conversations with the question: "Have I handled your complaint satisfactory?"".

Kicken et al. (2008) advise to gradually decrease the detail and frequency of advice on the formulation of Pfls. In the PERFLECT work-flow this kind of second-order scaffolding is implemented in the coaching sessions. The first way to do this is by gradually decreasing the number of aspects that advice is given on. Whereas in the beginning the student is offered advice on all four aspects of well-formulated Pfls, later on this might be decreased to three or two aspects and in the end to no aspects at all. Second, the student is stimulated to gradually formulate learning goals that are more ambitious. If the aforementioned store manager trainee has succeeded in asking 50% of his customers about their satisfaction with the way their complaint was handled, he might be suggested to aim for a higher percentage. Finally, the frequency of the advice that was given can be decreased, for example from once every week to once every two weeks.

The final way PERFLECT supports the development of SDL skills is by helping students to select future learning tasks. In the PERFLECT work-flow this is mainly implemented in the coaching sessions. Future learning task selection is driven by two questions in these sessions. First, the students are asked if they want to execute the following learning task with less support, the same amount of support, or more support. Second, students are asked if they think they are ready to perform more difficult learning tasks. The answers to these questions form the basis for a discussion between the teacher and the students. By discussing similarities and discrepancies between points of view of the students and their teacher, the students are supported with the selection of learning tasks that fit their learning needs.

Similar to the diminishing advice for the formulation of learning goals, Kicken et al. (2008) advise to gradually decrease the detail and frequency of advice given on future learning task selection. This means that at first students receive a substantial amount of support and guidance when they answer the two leading questions. The amount of support and guidance will be slowly diminished. The same is true for the frequency at which advice is dispensed. A second way to apply second-order scaffolding is by limiting the amount of the learning tasks students can choose from. This means that at first, the teacher will pre-select some learning tasks for students so that it is easier to select an appropriate learning task. As the students become more proficient at selecting new learning tasks, the pre-selection will include more learning tasks, until finally the teacher makes no pre-selection at all.

The three functionalities previously discussed are implemented to ensure that PERFLECT facilitates a smooth transition from teacher-directed learning to student-directed learning. The following section describes a small-scale empirical

evaluation of working with PERFLECT. The aim of this evaluation was twofold. One part of the evaluation was aimed at investigating how PERFLECT actually supports the development of SDL skills. The other part was aimed at identifying ways to improve PERFLECT both in terms of functionality as well as in terms of usability.

Evaluation

Method

This study comprised a total of 22 students between the ages of 16 and 21 years ($M = 17.7$, $SD = 1.3$). The participants were all students of senior vocational education at an institute in the western region of the Netherlands. Students of pedagogical work ($n = 5$) and media development ($n = 17$) participated. The sample included 14 males (70%) and six females (30%). Two teachers participated in the study, one teacher of pedagogical work and one teacher of media development.

We used a coaching protocol to shape the student-teacher conversation during the coaching sessions. This protocol specifies the minimal content of a coaching-session conversation. It is divided in three sections. The first section is aimed at assessment of performance on learning tasks. This section contained two questions: “Has the student completed at least one self-assessment per day?”, and “Has the student selected the relevant core tasks and working processes?”. The second section of the coaching protocol was aimed at supporting the formulation of Pfls. The four questions in this section included: “Are the formulated Pfls specific enough?”, “Do the formulated Pfls describe concrete behavior?”, “Are the formulated Pfls realistic?”, and “Are the formulated Pfls time-bound?”. The last section is aimed at future task selection and contains one question: “Which future learning task fits the students learning needs?”

The teacher was asked to make short notes during the coaching session on a note sheet. This sheet was designed to complement the coaching protocol. It was divided in the exact same sections as the coaching protocol was. In essence the coaching protocol and the coaching session note sheet were the same document with one important difference. While the coaching protocol contained explanations about its respective sections, the coaching session note sheet contained blank rectangular areas in these places. This allowed the teacher to write down if he agreed with the student, and if necessary explain why or why not.

All participating students and teachers attended an introductory workshop about working with PERFLECT. The workshop was divided in two parts. The first part of the workshop was aimed at illustrating the benefits of working with PERFLECT. The second part of the workshop was aimed at instructing students how to use the portfolio. After the

workshop students were asked to use PERFLECT over a period of three weeks to self-assess their performance on learning tasks. While students were encouraged to engage in daily self-assessments, they were not obliged to do so. We refrained from this obligation, because we wanted to offer the students autonomy in using PERFLECT. This was done to promote intrinsic motivation (Ryan and Deci 2000). Yet, at the same time we were aware of the importance of regular reflection, thus we encouraged the students to use it daily. Asking them about their frequency of use was meant to provide an indication of actual use.

In addition to regularly performing self-assessments some students participated in coaching sessions that were designed to complement the self-assessment process. About halfway through the study, it was tried out with the five students of media development. Teacher coaching occurred in 15-min sessions. The teacher was instructed to discuss all sections of the coaching protocol to ensure a uniform coaching session experience for all students. However, the teacher was allowed to provide additional comments if there was a need to do so.

At the end of the study all students were asked to fill out the evaluation questionnaire. They were individually asked to describe their perceptions of PERFLECTs usability, utility, and ability to support SDL, in an interview using the questionnaire as framework. These interviews were recorded. Finally, the same questionnaire served as basis for discussion with the media development teacher about PERFLECT and its ability to support the development of SDL. This interview was also recorded. The pedagogical work teacher was not available for an interview.

Results

The 22 participating students used PERFLECT to assess a total of 44 learning tasks, which is about two learning tasks per student ($M = 2.2$, $SD = 1.3$). Additionally, they formulated 44 Pfls. However, not all of these Pfls were meaningful. After subtraction of meaningless Pfls such as “nothing” and “-”, 34 Pfls remained. On average, a little less than two Pfls were formulated per student over the study period ($M = 1.7$, $SD = 1.2$). For the most part, these points were broadly formulated. Examples of formulated Pfls include “I need to pay attention more often”, “I have to work according to guidelines”, and “I have to prepare the activity”. As was mentioned before, selection of new learning tasks is an integral part of the coaching sessions in the PERFLECT work-flow. It was only a small part of this study because the coaching sessions were not piloted with all students. Analysis of the coaching session note sheets shows that the teacher often had to steer students in the right direction when it came to selecting the appropriate criteria for self-assessments. The teacher noted that none of the five students had selected the appropriate criteria for these assessments before the session. The teacher agreed with all the

PfIs the students had formulated. Notes regarding the future task selection only indicated that the topic was discussed, such as “yes”, but did not provide any conclusive information as to what was discussed.

The evaluation questionnaire was filled out by 17 of the 22 students. Mean scores and standard deviations are reported in Table 1.

Results in this table show that students were satisfied about PERFLECTs usability and utility ($M = 3.8$, $SD = 1.0$). Positive perceptions are also reported on PERFLECTs ability to support their development of SDL skills. Students were satisfied with PERFLECTs ability to help them self-assess their performance on learning tasks ($M = 3.9$, $SD = 0.9$). The same is true for PERFLECTs ability to help students formulate PfIs ($M = 3.8$, $SD = 0.8$). Finally, students report very positive perceptions about PERFLECTs ability to help them select future tasks ($M = 4.0$, $SD = 0.8$).

Discussion

This design case described the outlines of PERFLECT, an electronic development portfolio aimed at supporting the development of SDL skills. It was built to support three iterative phases of SDL: self-assessment, formulation of PfIs and learning goals, and selection of future learning tasks. As part of the design process we aimed to evaluate whether PERFLECT was able to support the three aforementioned phases of SDL, whether it was perceived to be usable and of utility, and what could be improved about PERFLECT.

There is an indication that PERFLECT supports the self-assessment of performance on learning tasks and the formulation of PfIs. Students reported that PERFLECT offered them valuable performance overviews and helped them gain insight into their strong and weak sides. This is strengthened by actual usage statistics. PERFLECT helped students to self-assess their performance about once a week and to formulate PfIs regularly. However, students had trouble with selecting the appropriate criteria for self-assessment and often formulated their PfIs poorly. This finding is in line with previous research which demonstrates that students cannot solely rely on an electronic portfolio for their development of SDL skills, they need additional coaching, at least in the beginning (e.g., Dornan et al. 2003; Driessen et al. 2005).

While students perceived PERFLECT to be able to help them to select future learning tasks, we were not fully able to test this particular functionality. As such it is not yet clear how successful PERFLECT actually is at supporting the selection of future learning tasks. For one part this is the case because selection of future learning tasks is an integral part of the coaching sessions, and these were only piloted with five students. For the other part, this is the case because PERFLECT was tested in an environment that did not allow students to select their own learning tasks. This means that choosing a future learning task was a fictional exercise, which can be demotivating.

Students are satisfied with the utility and usability of PERFLECT. This is reflected in both the evaluation questionnaire as well as the semi-structured interviews. They mainly appreciate that PERFLECT is well-arranged, which allows

Table 1 Mean scores and standard deviations on the evaluation questionnaire

Constructs and constituent items	Score ^a	
	<i>M</i> (1–5)	<i>SD</i>
Perceived usability and utility	3.8	1.0
1. It was clear to me what the aim of PERFLECT was.	4.2	1.0
2. It was easy to use PERFLECT.	3.7	0.9
3. I found it useful to make use of PERFLECT.	3.7	0.9
4. Working with PERFLECT was educational.	3.5	1.1
Perceived ability to support self-assessment	3.9	0.9
5. PERFLECT provided a good overview of my performance on learning tasks.	4.2	1.0
6. I was stimulated by PERFLECT to think about my strong sides.	3.5	0.8
7. I was stimulated by PERFLECT to think about my weak sides.	4.0	0.9
8. I was stimulated by PERFLECT to think about my performance on learning tasks.	3.9	0.9
Perceived ability to support formulation of points for improvement	3.8	0.8
9. I was stimulated by PERFLECT to think about how I can improve my weak sides.	3.8	0.8
Perceived ability to support future task selection	4.0	0.8
10. PERFLECT helped me think about what I should pay attention to with new learning tasks	4.0	0.8

Construct means were calculated by averaging construct constituent means

^a $n = 17$

them to access information efficiently. The improvement suggestions indicate that some thought has to be given to the organization of information and language use in PERFLECT towards follow-up studies. Connections between the various parts of the qualification dossier and nationwide generic vocational competences should be made apparent. Furthermore, the frequency of self-assessments need to be evaluated and PERFLECTs lay-out should be improved.

Limitations

The pilot study had a duration period of only three weeks. As such, it is hard to generalize findings of this small-scale, short-period study. However, this is not necessarily an issue. The pilot study was explicitly aimed at fine-tuning PERFLECT and identifying possible chances and risks for more ambitious interventions. In those terms the study was successful.

We had expected to test PERFLECT in an on-demand education environment, but this did not turn out to be the case. As such we have limited insight in PERFLECT's ability to help students select future learning tasks.

Future Research

In order to effectively develop SDL skills it is important that self-assessments of performance are accurate. These cannot be accurate if students do not select the appropriate assessment criteria. Moreover, even if students select the right assessment criteria it is likely that they will not accurately self-assess their performance, this is a consistent finding in the literature (e.g., Dunlosky and Lipko 2007). To help students improve at selecting the appropriate criteria, they should receive support and guidance. For example, the appropriate assessment criteria could be pre-selected when students start to self-assess their performance. As they progress, the responsibility for criteria selection should then gradually shift towards them. To improve self-assessment accuracy students should be able to access information that describes their performance objectively, when they engage in self-assessment. Possibly students can learn from the discrepancies between their own judgments and those of their teachers. We propose that future studies investigate if self-assessment accuracy can profit from automatically confronting students with such discrepancies and prompting them to explain these differences.

Optimally, students' formulations of Pfls are concrete and meaningful. In our current setup the teacher provides both cognitive feedback and corrective feedback to the students in the coaching sessions about formulating Pfls. The cognitive feedback is aimed at helping students understand how to formulate Pfls. The corrective feedback is aimed at identifying common errors and misconceptions and reducing these. This is a suboptimal situation. Optimally, corrective feedback on task performance should be provided as the learning task is

performed (Hattie and Timperley 2007). We propose that future research focuses on developing algorithms that analyze submitted Pfls on common mistakes and offer immediate, corrective feedback.

Conclusion

PERFLECT is a promising tool to support the development of students SDL skills, including self-assessment of performance, formulation of Pfls and selection of future learning tasks. Additional coaching aimed at providing second-order scaffolds is essential to ensure the students' SDL skills develop effectively.

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Compliance with Ethical Standards

Conflict of Interest All authors report no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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