Are Non-Experts Able to Comprehend Business Process Models - Study Insights Involving Novices and Experts

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Abstract. The comprehension of business process models is crucial for enterprises. Prior research has shown that children as well as adolescents perceive and interpret graphical representations in a different manner compared to grown-ups. To evaluate this, observations in the context of business process models are presented in this paper obtained from a study on visual literacy in cultural education. We demonstrate that adolescents without expertise in process model comprehension are able to correctly interpret business process models expressed in terms of BPMN 2.0. In a comprehensive study, \( n = 205 \) learners (i.e., pupils at the age of 15) needed to answer questions related to process models they were confronted with, reflecting different levels of complexity. In addition, process models were created with varying styles of element labels. Study results indicate that an abstract description (i.e., using only alphabetic letters) of process models is understood more easily compared to concrete or pseudo descriptions. As benchmark, results are compared with the ones of modeling experts (\( n = 40 \)). Amongst others, study findings suggest using abstract descriptions in order to introduce novices to process modeling notations. With the obtained insights, we highlight that process models can be properly comprehended by novices.

Keywords: Business Process Model Comprehension, Visual Literacy, Cultural Education, Human-Centered Design

1 Introduction

Business process models constitute crucial artifacts for optimizing the operational efficiency of enterprises. The demand for process models of high quality, which properly capture the business processes of an enterprise, has increased during the last years [1]. To assist enterprises in meeting this demand, considerable
research has been spent on better understanding these factors that characterize process models of high quality \[2\]. However, as a prerequisite for an effective use of process models, the latter must be properly understood by individuals \[4\]. Concerning process model comprehension, an individual must parse information related to the syntactics, semantics, and pragmatics of a process modeling notation \[5\]. Prior research has shown that individuals apply different strategies for interpreting and comprehending process models \[6\]. In this context, it is known that children, adolescents, and grown-ups perceive their surroundings differently. As a consequence, they use varying strategies for interpreting and learning artifacts \[7,8\]. In certain cases, children and adolescents show an equivalent or even better performance in accomplishing cognitive tasks compared to grown-ups \[9,10\]. This raises the issue whether children and adolescents are also able to comprehend business process models, even though they have no previous knowledge in any process modeling notation. Following this, first, we believe that from corresponding insights we can draw conclusions fostering the comprehension of process models. Second, modeling guidelines (e.g., 7PMG \[11\]) towards creating better comprehensible process models might be derived. Third, BPM modeling tools can be augmented with features to foster the learning of process modeling notations and, thus, the comprehensibility of business process models.

This paper presents the results of a comprehensive study on visual literacy in cultural education. More specific, a representative sample (\(n = 205\)) of pupils at the age of 15 from different kinds of German schools are confronted with a visual task related to process model comprehension. Particularly, the pupils have no previous knowledge on any process modeling notation. The objective of the study is to evaluate whether pupils (i.e., novices) comprehend process models correctly. Study results imply that pupils are able to comprehend process models. Further, as a benchmark, a similar study is conducted with participants having expertise in the domain of process modeling. Based on the study results, we give recommendations on how to foster process model comprehension.

The remainder of the paper is organized as follows: Section 2 explains the study context and Section 3 the study settings. Study results, in turn, are presented, analyzed, and discussed in Section 4. Section 5 addresses related work. Finally, Section 6 summarizes the paper and gives an outlook.

## 2 Study Context

The presented results are obtained from a large-scale study in a project focusing on the visual literacy in cultural education.\[1\] The purpose of this project is to gain insights into how visual literacy can be fostered and empirically measured \[12\]. Thereby, visual literacy denotes a concept defining the capability to interpret, understand, and extract information presented in images \[13\]. Furthermore, studies have shown that the use of appropriate images foster learning processes as well as the development of learning strategies \[14\]. The project analyzes the

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1 https://www.dipf.de/en/research/current-projects/bkkb-visual-literacy-in-cultural-education?set_language=en
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variation between motivation and perception of learners (e.g., pupils, students) about instructional quality with regard to visual literacy in cultural education. A particular emphasis is put on the effects of cultural capital (i.e., social assets like education) and cultural-aesthetic practices (e.g., religious beliefs) of learners. Cultural education will be assessed in the European Framework of Visual Literacy (ENViL) in a series of nationwide studies across various kinds of schools (e.g., secondary school, university) in Germany [15]. For this purpose, a mobile application was developed to assess visual literacy. In more detail, learners are asked to run through various visual tasks (e.g., Dalli-Click, Mental Rotation) and a set of questions [16]. Additional data are collected through eye tracking to reveal insights into learning processes and strategies (cf. Fig. 1).

To the aforementioned study, we contribute a visual task that deals with the comprehension of process models. In particular, the focus lies primarily on semantics and syntactics of process models expressed in BPMN 2.0 [17,18]. With this task, we want to investigate the following objectives with respect to process model comprehension:

| Objectives for Process Model Comprehension |
|-------------------------------------------|
| – Can process model semantics be interpreted by learners? |
| – Can process model syntactics be comprehended by learners? |
| – Does the interpretation and comprehension of process models change when taking cultural education into account? |

The study results, in turn, can be used to discover directives on how to foster process model comprehension. Moreover, the introduction of modeling notations to novices might be improved and BPM tools could be enhanced with features fostering process model comprehension. As a benchmark, we conduct a similar study with participants experienced with business process modeling. In detail, instead of carrying out the entire visual literacy study as for pupils, including all visual tasks and questions, in the benchmark study, participants only need to answer questions on their process modeling experience. Furthermore, they only solve the process model comprehension task. Fig. 1 summarizes the described study context of visual literacy.

3 Study Setting

In general, there are many factors that have effects on the comprehension of process models [19]. Amongst others, the size of a process model (i.e., level of complexity) and the quality of element labels are such factors [20,21]. The latter is relevant for the semantic description of process models, which comprises the textual as well as informational content. In practice, the use of concrete labels (e.g., verb-object style) is common. However, abstract labels (i.e., alphabetic letters) may be used, if the semantic description of a process model is not relevant, e.g., when getting into touch with process modeling notations for the first time. In the study, we introduce an additional labeling style for elements using pseudo
labels, i.e., we generate appropriate pseudowords for all nouns, derived from the concrete labeling style. The different labeling styles (i.e., concrete, abstract, and pseudo) are denoted as levels of semantics in the following. Based on these two factors (i.e., level of complexity and level of semantics), the following three research questions (RQ 1 - RQ 3) are addressed with learners pupils in the study:

RQ 1: How do pupils (i.e., novices) perform when reading and comprehending BPMN 2.0 process models of different levels of complexity?

RQ 2: How do pupils (i.e., novices) perform when reading and comprehending BPMN 2.0 process models of different levels of semantics?

RQ 3: How do pupils (i.e., novices) perform with respect to the reading and comprehension of BPMN 2.0 process models compared to process modeling experts?

3.1 Study Planning

Participants. Study participants form two samples. The first sample comprises pupils at the age of 15 from different kinds of German schools. The second sample, in turn, either refers to students or research associates (i.e., process modeling experts) at Ulm University. The latter are invited separately for participating in the benchmark study. As a prerequisite for participating in the study, benchmark participants need to have a sufficient expertise level in process modeling.

Objects. The objects include three process models expressed in terms of BPMN 2.0. As being frequently used in practice, BPMN 2.0 suits to the context of this research. The process models are divided into three levels of complexity (i.e., easy, medium, and hard). The easy process model only comprises a sequence of basic elements (i.e., activities, events). With rising level of complexity, new elements, previously not contained in the process model, as well as specific modeling constructs (e.g., loop) are added and the total number of elements is increased. Moreover, the process models represent different scenarios the participants have experienced repeatedly in their daily lives, i.e., taking the bus home, browsing Facebook while listening to music, and writing an exam.

For each level of complexity, the corresponding process models reflect three levels of semantics (i.e., concrete, abstract, and pseudo). For creating the latter, we use
the multilingual pseudoword generator Wuggy [22]. Figs. 2 a - c illustrate the labeling styles corresponding to the three levels of semantics. For each process model, four statements on its semantics are presented to the participants, who then need to answer which of the four statements are correct. More precisely, two of the four statements are true, whereas the two others are false (i.e., two-out-of-four combination). Thereby, no information is given to the participants about the two-out-of-four combination. The statements are used to evaluate whether or not the participants interpret the process models correctly. For collecting answers, check boxes are placed beneath each statement, i.e., participants can easily select or deselect statements (cf. Sect. 3.3). Initially, all statements are deselected. To enable a comparability of the different process models, process modeling experts as well as novices, who do not participate in the study, are asked to rank and categorize the process models with respect to their level of complexity and level of semantics. Finally, a steady increase in the level of complexity is ensured by applying quality metrics for process models [23].

**Independent variables.** The study comprises three independent variables, i.e., for each process model, the level of complexity (i.e., easy, medium, and hard), the level of semantics (i.e., concrete, abstract, and pseudo), and, only for the benchmark study, the level of expertise on process modeling of experts.

**Dependent variables.** Dependent variables are the achieved score regarding the statements and the duration needed for comprehending a process model.

![Fig. 2: Levels of Semantics](https://drive.google.com/uc?export=view&id=1ODBzR1eS0Tv5hhNyf6A1ai-R39HVH6Ks)

### 3.2 Study Design and Procedure

Prior to the primary study, a pilot study with 17 students was performed to evaluate the used process models and statements as well as to eliminate misunderstandings and ambiguities. The pupils are told that the study contains process model comprehension tasks. In turn, the experts are informed that the study deals with process model comprehension. Both samples are asked to perform the task of the study as quickly as possible and as careful as possible. As described in Sect. 2, there are two different procedures for pupils and experts.

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2 Material download at: [https://drive.google.com/open?id=1ODBzR1eS0Tv5hhNyf6A1ai-R39HVH6Ks](https://drive.google.com/open?id=1ODBzR1eS0Tv5hhNyf6A1ai-R39HVH6Ks)
during the execution of the study (cf. Fig. 3). Pupils i need to work on a predefined sequence of visual tasks related to visual literacy and answer a number of questions providing personal information (e.g., age, gender) and cultural capital (cf. Sect. 2). Regarding the process model comprehension task, a corresponding description is displayed on the tablets that explains what needs to be done. In particular, the pupils are asked to read and comprehend the depicted process models, starting with the process model reflecting an easy level of complexity, followed by the process model with medium level of complexity, and the one with hard level of complexity. Thereby, each pupil is randomly assigned to a specific level of semantics (i.e., concrete, abstract, or pseudo) such that all elements in the three process models use the same element labeling style.

Regarding the experts 2, general study information is presented, followed by a demographic questionnaire (e.g., age, gender). A particular focus is put on questions related to the expert’s present knowledge on process modeling and the number of process models he or she has analyzed and created during the last 12 months. After completing this mandatory step, experts are confronted with the same task on process model comprehension as the pupils. While the pupils have to solve and answer additional visual tasks and questions, for the experts the study ends after completing the respective comprehension task. Fig. 3 illustrates the two study designs for pupils and experts.

3.3 Instrumentation

The study is performed using a Samsung Galaxy Tab A6. Therefore, we developed a mobile application, which serves as an instrument allowing for the planning and execution of studies in the context of visual literacy. It comprises a variety of customizable questions as well as visual tasks (e.g., Dalli-Click, Mental Rotation). Emerging study data is collected with the mobile application. Fig. 4 illustrates the user interface of the mobile application, showing the screen when performing the visual task related to process model comprehension. Finally, IBM SPSS Statistics 23 is used for all statistical analyses.
A total of 268 participants are recruited for both studies, forming two samples. The first one consists of 228 learners (i.e., pupils, students) from different types of German schools. As solely pupils are considered, data sets produced by other learners are removed (i.e., 23 in total), leaving $n = 205$ data sets left for statistical analyses. The second sample, in turn, consists of students and research associates from Ulm University, stemming from various departments (e.g., Computer Science, Economics). As a prerequisite for their selection, they must have a sufficient expertise level in business process modeling. Accordingly, this sample is classified as process modeling experts and used as a benchmark for evaluating the results obtained from the study with pupils. Finally, the stated research questions (cf. Sect. 3.1) are investigated for $n = 205$ pupils (i.e., novices) around the age of 15 and $n = 40$ modeling experts respectively. Table 1 summarizes the sample descriptions, displaying general information (with standard deviation (SD)) on the total number of participants, their average age, and gender balance. Concerning process modeling experience, the average number of process models analyzed and created during the last 12 months is shown as well as the average number of activities in these process models. Regarding the novices, no such data is available (NA) as they have no experience in process modeling and process model comprehension respectively. Finally, for each level of semantics (i.e., concrete, abstract, and pseudo), its distribution is presented in Table 1.

4.1 Descriptive Statistics

Table 2 presents the mean ($M$) as well as the standard deviation (SD) for all values obtained by novices (i.e., pupils) and experts. For each level of complexity (i.e., easy, medium, and hard) and each level of semantics (i.e., concrete, abstract, and pseudo), the achieved score in correctly selecting the right statements as well as the duration needed (in s) to solve the task are shown in Table 2. Note that
| Variable                          | Novices | Experts |
|----------------------------------|---------|---------|
| **General Information**          |         |         |
| Number                           | 205     | 40      |
| Age (SD)                         | 15.20 (.95) | 27.30 (6.33) |
| Gender (f / m)                   | 98 / 107 | 9 / 31  |
| **Experience in Process Modeling**|         |         |
| Analyzed (SD)                    | NA      | 24.43 (21.39) |
| Created (SD)                     |         | 19.48 (20.33) |
| Activities (SD)                  |         | 15.70 (7.69)  |
| **Level of Semantics**           |         |         |
| Concrete                         | 75      | 14      |
| Abstract                         | 58      | 14      |
| Pseudo                           | 72      | 12      |

Table 1: Sample Descriptions for Novices and Experts

only the identification of a correct statement result in a point (i.e., two points are the maximum for each level of complexity).

Figs. 5 - 10 depict descriptive data (means) of novices (i.e., pupils) and experts with corresponding standard error\(^3\). When juxtaposing the results shown in Figs. 5 and 6, they present the achieved score in identifying the correct statements. Instead of an expected steady decrease of the score with rising level of complexity, the score for the medium process model is erratic for both samples.

| Indep. & Dep. Var. | Concrete M (SD) | Abstract M (SD) | Pseudo M (SD) |
|--------------------|----------------|----------------|---------------|
| **Novices**        | Score          | Duration       | Score         | Duration       | Score         | Duration       |
| Easy               | 1.04 (.68)     | 2282.60 (821.78) | 1.62 (.64) | 1742.00 (651.41) | 1.13 (.60) | 3474.19 (1877.23) |
| Medium             | .88 (.66)      | 2410.03 (1019.28) | .53 (.60) | 2383.98 (1308.19) | .63 (.70) | 2475 (1618.57) |
| Hard               | 1.04 (.73)     | 2582.92 (1729.61) | 1.19 (.58) | 2516.57 (2123.66) | .82 (.61) | 2331.37 (2154.54) |
| **Experts**        | Score          | Duration       | Score         | Duration       | Score         | Duration       |
| Easy               | 1.43 (.51)     | 2360.86 (668.82) | 1.93 (.27) | 2061.57 (642.45) | 1.17 (.58) | 3656.42 (1110.17) |
| Medium             | 1.43 (.65)     | 2177.71 (803.76) | 1.64 (.63) | 2255.14 (599.44) | 1.58 (.52) | 3379.42 (954.74) |
| Hard               | 1.36 (.48)     | 4016.57 (1495.65) | 1.64 (.48) | 4079.07 (1475.68) | 1.17 (.72) | 6755.25 (2384.94) |

Table 2: Descriptive Results for Novices and Experts

Regarding the duration needed by pupils for corresponding process models (cf. Fig. 7), a clear difference between the different levels of semantics can be

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\(^3\) Standard error is used to estimate the standard deviation of a sampling distribution
observed in the easy process model. However, the duration to solve a task reaches the same value with increasing level of complexity. For experts (cf. Fig. 8), tasks with process models reflecting an abstract and concrete level of semantics are solved faster than the pseudo ones.

As depicted in Fig. 9, experts show a better performance in comprehending process models compared to the novices (i.e., pupils). According to Fig. 10, interestingly process models showing an abstract level of semantics are understood easier than models with a concrete or pseudo level of semantics, thus abstract labels having a positive effect on process model comprehension. However, these observations are merely based on descriptive statistics. For a more rigid investigation, dependent variables are tested for statistical significance.
4.2 Inferential Statistics

The analysis of variance (ANOVA) for repeated measurements is performed for each dependent variable (i.e., score and duration). Thereby, main effects (ME) and interaction effects (IE) are considered. The main effects for level of complexity (ME 1), level of semantics (ME 2), and level of expertise (ME 3) are investigated (cf. Sect 3.2). Furthermore, the following interaction effects are analyzed: complexity*semantics (IE 1), complexity*expertise (IE 2), semantics*expertise (IE 3), and complexity*semantics*expertise (IE 4). All statistical tests are performed two-tailed with the significance value being set to $p < .05$.

Table 3 presents the results calculated for both samples as well as for novices (n) (i.e., pupils) and experts (e) being considered separately.

In summary, for both samples, the statistical analyses show a high significance for all variables, except the value for IE 4 regarding the score and IE 1 regarding the duration. Thereby, the latter almost reaches statistical significance. Concerning the score achieved by novices, there are significant differences between the level of complexity ($ME_n 1$) and the level of semantics ($ME_n 2$). Consequently, the interaction effect between these two variables reaches statistical significance ($IE_n 1$). Concerning the duration, there is no significant difference regarding the level of complexity ($ME_n 1$). By contrast, a statistical significance related to the level of semantics ($ME_n 2$) is measurable. Consequently, the interaction effect shows a statistically significant result ($IE_n 1$). Regarding the experts’ score, there is no significant difference regarding the level of complexity ($ME_e 1$), but statistical significance is observable between the level of semantics ($ME_e 2$). Furthermore, the interaction effect shows no significant difference ($IE_e 1$). Considering the duration, there are significant differences between the level of complexity ($ME_e 1$) as well as the level of semantics ($ME_e 2$) and, hence, likewise the interaction effect reflects a significant difference ($IE_e 1$).

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4 ME is the effect of the variable averaging over all levels of the same variable.

5 IE measures the interaction of a variable with another variable(s).
Concerning the concrete level of semantics, during process model comprehension, pupils seem to consider their own experiences with the respective process scenario. In particular, they try to match the given statements with their own process reflection of the scenario in their minds and, therefore, answer related statements based on syllogisms, though the answers might be false. As pseudowords reflect no lexical semantics, they appear to be an additional challenge for pupils. A clear difference with respect to the duration needed to comprehend a process model can be observed for the easy process models, the comprehension duration reaches the same value for all levels of semantics with increasing level of complexity (RQ 2 + RQ 3). Note that with a pseudo labeling, a decrease of the duration needed can be observed. However, the same effect cannot be observed for the score achieved. This can be explained by the fact that a learning
effect occurs between the *levels of complexity*, leading to a faster comprehension of respective process models [24].

Concerning the *medium* process model, a particular phenomenon is discernible (cf. Figs. 5 and 6). The pupils showed a significant decrease in the *score*, while the *score* increases for the *hard* process model. In turn, experts achieved a slightly better result regarding the *score* for the *medium* process model, but showed a decrease for the *hard* model. One might anticipate that the *scores* will decrease with rising *level of complexity*.

Having a closer look at the process model with a *medium level of complexity*, one can see that the model comprises a parallel path (i.e., AND gateway) as well as a loop (i.e., XOR gateway). Moreover, the two correct statements associated with this model refer to the interpretation of the parallel path and the loop. According to the results, pupils seem to experience difficulties in the correct interpretation of the parallel path. The loop, in turn, is comprehended correctly by them. The same effect can be observed in the subsequent task related to the comprehension of the *hard* process model. The *hard* process model comprises a parallel path, a loop, and two decision points (i.e., XOR gateway). The statements in this model refer on the interpretation of the XOR gateways (i.e., loop and decision points). Pupils are able to interpret and comprehend the loop as well as the decision points correctly, which does not fully apply to the parallel path. This reconfirms observations we made in a prior study, which revealed that the first gateway appearing along the reading direction seems to be more challenging to comprehend compared to the subsequent ones [6]. A common approach for interpreting a gateway is to consider the process scenario in more detail. This way, the behavior of the remaining gateways can be derived.

Regarding the *scores* achieved by the experts and they *duration* needed, it has become evident that process models with an *abstract level of semantics* are comprehended easier compared to models with *concrete* and *pseudo* labels. Moreover, process models with an *abstract level of semantics* are comprehended fastest, whereas for the other two *levels of semantics*, the *duration* needed to comprehend respective process models is approximately the same. Experts achieved a considerably better *score* in identifying the correct statements compared to pupils. However, experts need more *time* for comprehending a process model. As a reason for this phenomenon, experts have spent more time in parsing information on the syntactics and semantics of a process model.

Our findings might have several implications. The conducted study provides information on how novices comprehend process models compared to experts. Interestingly, the use of an *abstract level of semantics* fosters learning of process modeling notations, e.g., reducing the complexity for parsing the semantic information of a process model and, hence, the focus can be set entirely on the syntactical interpretation of the modeling language. This insight might be useful for the analysis of process models which are syntactically not sound. In general, process models can be read and comprehended intuitively. On the other hand, particular modeling constructs (e.g., AND gateway) seem to be more challenging to comprehend compared to others (e.g., XOR gateway). This indicates to focus
on modeling constructs and their respective behavior, which are likely to be more
difficult to comprehend. Moreover, based on our findings, modeling guidelines
can be derived towards creating better comprehensible process models.

4.4 Threats to Validity

Although validity factors are carefully considered, there are threats to validity
that need to be discussed. First, the use of two different procedures underlying
the study for pupils and experts limit its validity. The procedure for pupils takes
significantly more completion time (~ 40 minutes) compared to the one of ex-
erts (~ 10 minutes). Hence, this might have a negative impact on the outcome,
due to particular state of minds (e.g., tiredness, boredom). Second, participants
could discovered that two statements are always true. As a consequence, they
know that always two statements need to be selected. Third, the respective level
of complexity reflected by the process models constitutes another threat to va-
lidity. The process models might be considerably unbalanced between the levels
of complexity. In detail, working memory capacity of participants may be ex-
ceeded. The same might be applied to the different levels of semantics as well as
the single statements related to the process models. Fourth, as another risk, no
professionals from industry are involved, but prospective ones (i.e., students).
Although various investigations have shown that students are proper substitutes
for professionals in empirical studies [25], results for professionals might differ.
Fifth, the representativeness of the results is limited due to the relatively small
sample of experts (n = 40), although this number is rather higher compared to
similar studies. Accordingly, the different sample sizes between pupils (n = 205)
and experts (n = 40) make it more probable to detect significant results for
pupils than for experts. Note that we currently address these limitations in other
studies to obtain more accurate results allowing for a further generalization.

5 Related Work

Research on process model comprehension can be classified into subjective and
objective comprehensibility. Regarding subjective comprehensibility, [26] gives insights into various character-
istics (e.g., theoretical knowledge) of an individual that influence process model
comprehension. In turn, [27] confirms that process scenarios from a familiar ap-
lication domain represents a key factor for understanding conceptual models.
Finally, [28] presents a study focusing on visual features of process models (i.e.,
flow consistency) and their impact on human perception of process models.
Regarding objective comprehensibility, [29] provides fifty guidelines for improving
BPMN 2.0 process models with respect to their comprehensibility. A systematic
literature review of the factors influencing the comprehension of process models
is presented in [30]. Moreover, [31] presents an experiment investigates the ef-
effects of integrating business rules into a process model.
The empirical study in [32] shows that subjects who are confronted with complex
process models quickly encounter cognitive limitations, which impairs process model comprehension. Finally, [33] demonstrated that confronting individuals with a cognitive overload will have an adverse effect on model comprehension. Various works in literature exist investigating how different types of labels (e.g., concrete or abstract) are interpreted, understood, and processed by individuals. For example, [34] demonstrates that reading pseudowords results in a higher cognitive load of the working memory, having a negative impact on the performance in processing respective tasks. In turn, [35] showed that letters, words, and simple text, with or without context, are read at different speeds based on a set of individual differences (e.g., intelligence).

Regarding the labeling of activities in process modeling, [36] presents different practices for labeling activities and examines their usability. Based on the insights obtained from this study, specific labeling styles are recommended for process modeling. In addition, the quality of activity labels is addressed in [20] and a technique for refactoring activity labels is presented. Finally, the visual design of element labels in a process model is addressed in [37], providing recommendations for the design of element labels in process models.

It is known that children as well as adolescents perceive and interpret their surroundings differently compared to grown-ups, e.g., [38] discusses issues when comparing children with grown-ups and, hence, why they have to be considered differently in research. Finally, [39] suggests to tackle research from a pupil’s perspective in order to unravel new learning strategies. However, to the best of our knowledge, so far no approach has investigated the influence of a learner’s visual literacy in cultural education on the comprehension of process models.

6 Summary and Outlook

This paper investigated whether novices (i.e., pupils) are able to comprehend business process models, although they have no previous knowledge on process model notations. In total, \(n = 205\) pupils had to solve a visual task related to process model comprehension. As a benchmark, we performed a similar study with \(n = 40\) process modeling experts. Although experts outperformed pupils in the respective comprehension tasks, the results indicate that process models can be properly understood by pupils as well. Thereby, process models with an abstract level of semantics are easier to comprehend compared to process models with a concrete or pseudo level of semantics. Based on these findings, one may conclude that using an abstract labeling of elements fosters the learning of process modeling notations. Moreover, abstract labels assist in the analysis of syntactically unsound process models. Our study provides empirical evidence to focus on process modeling constructs that are likely to be difficult to comprehend (e.g., AND gateway). Our insights suggest that it might be beneficial to provide additional guidance in reading such constructs. Furthermore, modeling guidelines (e.g., 7PMG [11]) for the creation of better comprehensible process models can be provided based on the findings derived from the conducted study as well as existing modeling tools can be enhanced with supplementary features.
Although our results reveal interesting insights, further research is required. Therefore, we will conduct more process model comprehension studies with pupils from higher classes as well as teachers, students, and graduates (i.e., learners) to investigate the effects of cultural education (e.g., educational years) on process model comprehension. Furthermore, we will analyze data obtained from eye tracking and compare the applied strategies of learners to read and comprehend a process model with the one of experts. Finally, we will consider the influence of visual literacy and cultural education of learners with respect to business process models in more detail. This might reveal insights on how to foster the comprehension of process models.

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