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Teachers’ conceptualization and enactment of twenty-first century competences: exploring dimensions for new curricula

Karmijn van de Oudeweetering* and Joke Voogt

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ABSTRACT
Despite the advocated importance of twenty-first century competences in education, it appears that they are not systematically integrated in national curricula, school curricula and classroom activities. Potential explanations can be found in the current ambiguity of definitions for twenty-first century competences and the absence of educational actors in curriculum development. Responding to both shortcomings, this study aims to explore how teachers’ conceptualization and enactment of twenty-first century competences constitute dimensions that can inform curricular guidelines. An exploratory factor analysis of teachers’ self-reported classroom activities that foster students’ twenty-first century competences was conducted. The data comprised responses of 2,804 primary- and secondary-school teachers to a web-survey about the perceived occurrence of specific classroom activities targeting twenty-first century competences. Results suggested six coherent dimensions of classroom activities that foster twenty-first century competences: digital literacy, innovative thinking, critical thinking and communication, (digital) citizenship, self-regulated learning, and (computer-supported) collaborative learning. Nevertheless, there were substantial interrelationships among the six dimensions. This demonstrated that teachers did not perceive twenty-first century competences to be fostered by disconnected classroom activities, but that they already have a more integrative conception of the curricular innovation. The implications of these findings for curricula, teaching practice and research are discussed.

1. Introduction
The past decades have been characterized by globalization, technological advancements and accelerated knowledge accumulation. Especially in industrialized countries, this has induced profound changes in the labor market and in society. First, it is seen that jobs require more flexible, interpersonal and ICT-related competences rather than specialized knowledge (Akçomak, Borghans, & Ter Weel, 2011; Anderson, 2008; Levy & Murnane, 2007). Moreover, new and more refined competences seem to be needed in order to

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promote societal and personal well-being (Morreale & Pearson, 2008; Thijs, Fisser, & Van der Hoeven, 2014). Since educational institutions are responsible for preparing young people for their professional, social and personal future, this seems to justify the need for a large-scale curriculum reform. Hence, governments of most industrialized countries have examined possibilities to address newly important competences, mainly referred to as twenty-first century skills or twenty-first century competences, in their education policy. Still, there are only few national curricula that include explicit guidelines to address twenty-first century competences (Ananiadou & Claro, 2009). This can at least partially explain why twenty-first century competences are barely systematically integrated in school curricula and classroom activities (Thijs et al., 2014).

Two main issues might obstruct the integration of twenty-first century competences in national curricula, school curricula and teachers’ practices. First, there is a notable inconsistency in the definitions, interpretations, terminologies and dimensionalities of twenty-first century competences (Voogt & Roblin, 2012; Dede, 2010; Pellegrino & Hilton, 2013). This complicates the translation of twenty-first century competences into clear and distinct learning objectives and associated classroom activities. Another concern is the absence of the educational sector in the debates and initiatives regarding curricular for twenty-first century competences (Voogt & Roblin, 2012). Since teachers’ interpretation of innovations play a prominent role in their enactment of curricula, commentaries from teachers can provide relevant insight in how the implementation of innovations can be improved (März & Kelchtermans, 2013; Van den Berg, Vandenberghhe, & Sleeegers, 1999). Hence, knowledge about teachers’ perception of their everyday practices and how these practices may coherently foster twenty-first century competences could help to formulate practicable and sustainable curricular guidelines for twenty-first century education. Consequently, the aim of this study is to explore how teachers’ conceptualization and enactment of twenty-first century competences in their classroom activities inform the development of twenty-first century curricula.

2. Conceptual framework

2.1. Conceptualizations of twenty-first century skills or competences?

Definitions for twenty-first century skills have currently been captured in several different frameworks by governmental organizations, like the EU and the OECD, as well as (semi-)commercial organizations including Partnership for twenty-first century skills (P21), Engauge and ATCS (see Table 1). As the overview shows, conceptualizations of and terminologies for twenty-first century skills still vary among actors and countries. As a response, the OECD is currently working on a potential universal framework that may help to make the definitions more understandable, supported and sustainable (OECD, 2017). Still, there have already been efforts to point out the commonalities in the conceptualization of twenty-first century skills or competences. A meta-review has pointed out that all frameworks include ICT-related competences, collaboration, communication and social and cultural competences. Furthermore, most acknowledge creativity, critical thinking and problem solving (Voogt & Roblin, 2012). In addition, some of the frameworks encompass outcomes that represent self-regulatory competences, like productivity or responsibility (Voogt & Roblin, 2012).
With respect to the discussions on these conceptualizations, several questions have arisen. First, different reviews of the documentation on twenty-first century skills have pointed out that the imperative for twenty-first century education does not represent a call for new types of knowledge. Instead, what is ‘new’ or specific to this century are the implications of technological advancements and the associated need for a new approach to the curriculum, its learning goals and its associated classroom activities (Kereluik, Mishra, Fahnoe, & Terry, 2013). Thus, although twenty-first century skills can be interpreted as specific concepts, it is found that most of the identified skills can be
considered generic skills that bear specific importance in digital contexts (Kereluik et al., 2013; Van Laar, Van Deursen, Van Dijk, & De Haan, 2017).

Another question that has arisen is whether twenty-first century curricula should focus on skills to perform specific tasks, or rather foster a new way of thinking that is more sustainable in light of the ongoing technological developments (Higgins, 2014). Skills generally represent habituated cognitive or physical abilities that are exercised in a specific practical context (Winterton, Delamare-Le Deist, & Stringfellow, 2006). Instead, competences are cognitive dispositions, which represent the ability to deal with context-dependent issues (Klieme, Hartig, & Rauch, 2008). Considering that digital environments are complex and continuously changing, it seems that twenty-first century competences suits the conceptualization of the intended demands in society best. For example, digital literacy is generally conceptualized as a time- and context-flexible proficiency to deal with different digital technologies and is considered to encompass habitual, cognitive, as well as attitudinal and social components (Coiro, Knobel, Lankshear, & Leu, 2014). This seems to suggest that, although most organizations refer to twenty-first century skills, they may be better conceptualized as competences.

In final question concerns the practical meaning and implications of the different twenty-first century competences. It appears that, despite the divergent terminology and explanations on the need for these specific competences, most concepts of twenty-first century competences or skills share a similar undertone (Dede, 2010). For example, media literacy, information literacy or ICT literacy are particular terms that included in the different frameworks (see Table 1). Still, they all seem to represent a broad range of competences that coincide with ICT use (e.g. Burkhardt et al., 2003; Partnership for 21st century skills, 2015). They are also conceptualized as digital literacy or new literacies, which are terms that scholars have used to urge a reconceptualization of literacies that should be taught and learned in our classrooms considering the ongoing digitalization (Voogt, Erstad, Dede, & Mishra, 2013; Leu, Kinzer, Coiro, & Cammack, 2004). Still, a definite and practicable definition of digital literacy is not yet developed, which makes the implications for teachers unclear (Leu et al., 2004). There are also competences that do not seem to represent novel concepts, like collaboration, communication, socio-cultural competences, creativity, critical thinking and problem solving. However, it is seen that technological advancements have altered their connotation and relevance in the current educational context (Voogt et al., 2013; Van Laar et al., 2017). For example, ICT has brought about challenges as well as opportunities for collaborative learning and knowledge construction (Arvaja, Häkkinen, & Kankaanranta, 2008; Barak & Ziv, 2013). Moreover, digital technologies are becoming increasingly important in effective and constructive communication (Dede, Korte, Nelson, Valdez, & Ward, 2005). Furthermore, creativity, problem solving and critical thinking can especially be important in the context of ICT, as new technologies provide complex problem situations and require flexible, higher-order thinking (Mishra, Koehler, & Henriksen, 2010). Finally, the Internet has given rise to alternative public environments that set new standards for responsible and critical behavior (Ananiadou & Claro, 2009). Thus, it seems that these competences reflect the need to redefine desired educational outcomes in light of their implications for digitalization in the twenty-first century. However, the differences in the terminology and dimensionalities between the frameworks obstruct an unequivocal understanding of these cognitive competences (see Table 1). In addition, there is an apparent disagreement whether competences like metacognition or self-direction should be defined as a related
thinking skill or as a personal or professional attitude (e.g. Burkhardt et al., 2003; Griffin, McGaw, & Care, 2012). This substantiates the need for clear and shared interpretation of the learning objectives that should be central in twenty-first century education.

### 2.2. Teachers’ agency and sense-making

In order to formulate definitions for twenty-first century competences that support practicable and viable curricula, it is important that teachers’ agency and sense-making is taken into consideration. Supporting teachers’ agency is particularly important, as it enhances their commitment to curricular goals and the quality of their practices (Priestley & Biesta, 2013; Ketelaar, Beijaard, Boshuizen, & Den Brok, 2012). Curricular guidelines, in turn, can mainly reinforce teachers’ agency when they correspond to their aspirations and perceptions of their professional contexts (Priestley, Edwards, Priestley, & Miller, 2012). This means that a close alignment between the written curriculum and teachers’ perception of their professional responsibilities can help to improve teachers’ agency and therewith the realization of curricula.

Closely related to teachers’ agency, and allegedly as important, is teacher’s sense-making (Ketelaar et al., 2012). Teachers’ sense-making processes in curricular reform involve their active engagement and interpretation of the curricular change, which is often influenced by the practical context and their own experiences (Spillane, Reiser, & Reimer, 2002). This is important for their enactment of the curriculum, as it includes task perceptions and knowledge that guide their professional actions (März & Kelchtermans, 2013). In turn, the practical choices that teachers make seem to affect their perception of their practices (Buxton et al., 2015). Thus, teachers’ existing professional perceptions might reflect their actions. Curricula that correspond to these perceptions could therefore facilitate the actual implementation of curricular goals.

### 3. The present study

This study is a secondary analysis of data obtained in a large-scale study among primary- and secondary-school teachers in the Netherlands (Thijs et al., 2014). The data were initially used to indicate the extent to which twenty-first century competences were systematically implemented in the Netherlands. We used this dataset to study teachers’ practical understandings of twenty-first century competences. The study is guided by the research question: ‘What are the dimensions in teachers’ perceived classroom activities that foster twenty-first century competences in their students?’ The identified dimensions help to formulate clear definitions of twenty-first century competences that align with teachers’ conceptualization and enactment of twenty-first century competences. Particularly, this knowledge could point out how practicable curricular guidelines that encourage the implementation of twenty-first century competences can be formulated.

### 4. Methods

#### 4.1. Participants

Based on a random selection of email addresses in a Dutch national database for teachers, 15,000 primary-school teachers and 18,000 secondary-school teachers have been
approached per email to participate in a web-survey. The web-surveys were sent out in April 2014. The respondents were able to respond within three weeks. To be included in the study, respondents had to (a) be employed in primary- or secondary education and (b) have at least part time teaching responsibilities.

Ultimately, the final sample encompassed $N = 2,804$ respondents. Tables 2–4 provide an overview of the characteristics of the sample, including the proportions and absolute numbers of teachers per age group, gender, sector, grade level, educational track and subject department. To estimate the representativeness of the sample, these data were compared against data on the national teacher workforce. These comparisons showed that female teachers and teachers in the youngest age category were underrepresented in the sample (see Table 2). Likewise, the proportion of primary-school teachers was remarkably small in this sample compared to their share in the national population (see Table 3). Although data on the national amount of teachers per grade level and subject department was unavailable, the proportion of teachers in pre-vocational track in the sample is relatively small considering that approximately 66 percent of the students in secondary education is in this track (Table 4) (Ministry of Education, Culture and Science, 2014).

### 4.2. Instrument

The web-survey represented ten dimensions in twenty-first century competences that are, based on extensive literature reviews, conceptualized by the Dutch Institute for...
Curriculum Development. Hence, these ten dimensions are generally used for the conceptualization of twenty-first century competences for curricula in the Netherlands. These dimensions informed the ten scales in the web-survey. For each scale, three to five items were developed that represented classroom activities aimed at fostering student learning of twenty-first century competences. The items were reviewed by experts in the field of twenty-first century competences and were pilot tested among primary- and secondary-school teachers (Thijs et al., 2014). The survey ultimately included a total of 40 items (see Table 5). The items were formulated, in Dutch, as ‘To what extent do you pay attention to the following activities? In my class, students learn…’ followed by a learning activity. An exemplary activity for creativity is ‘to take new steps to gain creative ideas.’ Response options were given on a five point Likert scale and ranged from 1 (= almost never) to 5 (= almost always). The primary analysis indicated that the scales had a Cronbach’s alpha of 0.74 and higher (Thijs et al., 2014), which suggests that the reliability of the measurement instrument is adequate.

4.3. Procedure

To inform the respondents about the purpose of the research project and the nature of their participation, the survey included a short introduction on the topic and the goal of the study, information on the involved organizations and the expected duration of the survey. To stimulate completion, it was explicated that the survey completers would be eligible for a price in the form of a tablet computer. In addition, the respondents were informed about the possibilities to receive a summary of the research results. Finally, the e-mail address of the executing research organization was given for any further questions.

5. Results

5.1. Preliminary analyses

The initial datasets had been assessed for validity, which implied that all cases with invariant or hurried responses were removed. Based on this data cleaning and the selection criteria, there were 3,335 eligible respondents. However, it appeared that attrition caused a significant issue for handling missing data. In total, 531 respondents (15.9%) had withdrawn prior to the end of the survey. Missing data analyses indicated that the respondents
who did not complete the survey ($M = 50.4$) had a significantly higher age than those who did complete the survey ($M = 48.5$), $t(732.6) = 3.80, p < .001$, and were more likely to be female (17%) than male (14.3%), $z = 2.1, p = 0.016$. In addition, missing data within the same scale or in a proximate scale within the survey were strongly correlated. Given the condition of not missing at random (NMAR) and the large number of missing data, the application of imputation methods could still cause bias in the parameter estimates (Tsikriktsis, 2005; Yuan & Bentler, 2000). Furthermore, the non-random nature of the sample was an additional argument to reasonably opt for listwise deletion. This resulted in complete datasets of 2,804 respondents. These datasets were used for the present study.

5.2. Assumptions

As the aim of this study was to identify uncharted dimensions, an exploratory factor analysis was conducted. The data on the selected forty items were assessed for their factorability. Correlations among the items indicated that each item had at least one inter-item correlation stronger than $r = .30$ and that all anti-image correlation diagonals were larger than $r = .50$. In addition, Bartlett’s test of sphericity provided evidence to reject the null hypothesis, $\chi^2 (780) = 73073.012, p < .001$, and Kaiser–Meyer–Olkin measure of sampling adequacy was .958. Finally, all initial communalities were larger than $h^2 = .30$. All of these indicators implied that the forty items were appropriate for factor analysis and that the analysis should generate distinguishable factors (Field, 2009; Williams, Onsman, & Brown, 2010).

Decisions about the rotation method, the extraction method and the number of factors to be extracted were based on the nature of the data and the aims of the study. Assuming that the underlying factors within the data were interrelated, oblique rotation methods seemed most appropriate (Field, 2009). Preliminary analyses indicated that specifically Promax rotation, in contrast to Oblimin, would yield interpretable results. In combination with this rotation method, Principal Axis extraction was an appropriate measure for exploratory factor analysis that generated coherent outcomes. Finally, while parallel analysis or scree test generated unintelligible large or small amounts of factors, Kaiser’s criterion seemed relevant with an interpretable amount of six factors. Although this criterion is criticized for its liberal approach to factor selection, Kaiser’s criterion is considered appropriate for datasets with sample sizes larger than $N = 300$ and with average communalities equal to or larger than $h^2 = .60$ (Field, 2009). Given that the sample size and the average extracted communality ($h^2 = .57$), Kaiser’s criterion seemed legitimate and meaningful.

The final selection of item-factor loadings was based on the assumption that larger samples allow low factor loadings to retain relevance (Field, 2009). Still, merely item-factor loadings higher than .30 were retained for the final results, as the inclusion of all minor factor loadings would not seem to serve sensible interpretations. Cross-loadings were retained as well, considering the aim to explore all possible factor-item relationships.

5.3. Findings

The results indicated six factors with 43 item-factor loadings higher than .30. Only one item, ‘use brainstorm techniques to gain new ideas’, did not have a factor loading higher than .30 and was therefore eliminated. The three items ‘adjust message to
audience’, ‘use digital technologies’ and ‘use new media critically’ loaded on two factors. Remaining items loaded higher than .30 on particularly one of the extracted factors. The six factors jointly explained 56.73 percent of the variance in the underlying construct of classroom activities for twenty-first century competences. Labels for the factors were formulated, based on the content of the loaded items and existing conceptualizations of twenty-first century competences. Table 6 demonstrates the six factors, their labels, items that loaded on the factors and the original scales the items belonged to. Hence, it illustrates how the factors that are formed based on teachers’ self-reported classroom activities are related to the initially conceptualized dimensions of twenty-first century competences.

The factor digital literacy explained the largest proportion of variance in the underlying concept of classroom activities for twenty-first century competences, followed by innovative thinking, critical thinking and –communication, (digital) citizenship, self-regulated learning and (computer-supported) collaboration. Inter-factor correlations were weak or moderate (see Table 7). Table 8 provides further descriptive statistics for the factors. Since the items represented the frequency of specific classroom activities, the mean scores on the factors were indicative of the relative recurrence of the identified and labeled activities. The results thus showed that teachers more frequently implemented activities related to digital literacy, innovative thinking or critical thinking and communication (see Table 8). The modest positive values of skewness (see Table 8) indicated that responses toward the implementation of twenty-first century competences were slightly more positive than negative. Moreover, the negative values of kurtosis demonstrated that extreme responses were more prevalent than would be assumed for normally distributed data. Withal, the internal consistency of the composite scales indicated a high consistency in the responses on the factors (see Table 8).

6. Discussion

6.1. Identification of dimensions

The general aim of this study was to propose definitions for twenty-first century competences that concur with teachers’ conceptualization and enactment of twenty-first century competences. It was expected that teachers’ perceptions of their practices could inform curricular guidelines for twenty-first century competences that support teachers’ agency and align with their sense making. In turn, this could improve the practicability and sustainability of the curriculum implementation. An exploratory factor analysis of teachers’ self-reported classroom activities was adopted to identify how teachers perceive coherent dimensions in their practices with respect to twenty-first century competences. The results indicate what classroom activities appear to cohere in teachers’ self-reports and might therefore constitute practically relevant dimensions in the implementation of twenty-first century competences.

6.1.1. Digital literacy

The results indicate digital literacy is a distinct dimension that incorporates items for ICT literacy, media literacy and information literacy (see Table 6). Hence, these dimensions
Table 6. Factor labels, variance explained, eigenvalues and item-factor loadings and communalities for the 40 items on twenty-first century competences ($N = 2804$).

<table>
<thead>
<tr>
<th>Factor</th>
<th>Item</th>
<th>Original scale</th>
<th>Loading</th>
<th>$h^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital literacy</td>
<td>Use different media</td>
<td>Communication</td>
<td>.70</td>
<td>.53</td>
</tr>
<tr>
<td>Variance explained: 37.0%</td>
<td>Adjust message to audience</td>
<td>Communication</td>
<td>.32</td>
<td>.50</td>
</tr>
<tr>
<td>Eigenvalue: 15.22</td>
<td>Use digital technologies</td>
<td>ICT-skills</td>
<td>.71</td>
<td>.45</td>
</tr>
<tr>
<td></td>
<td>Use text- or presentation software</td>
<td>ICT-skills</td>
<td>.90</td>
<td>.68</td>
</tr>
<tr>
<td></td>
<td>Assess possibilities for computers to solve problems</td>
<td>ICT-skills</td>
<td>.59</td>
<td>.32</td>
</tr>
<tr>
<td></td>
<td>Understand the influence of media on society and themselves</td>
<td>Media literacy</td>
<td>.59</td>
<td>.60</td>
</tr>
<tr>
<td></td>
<td>Use social media to construct and share info</td>
<td>Media literacy</td>
<td>.77</td>
<td>.62</td>
</tr>
<tr>
<td></td>
<td>Constructively participate in social media</td>
<td>Media literacy</td>
<td>.59</td>
<td>.38</td>
</tr>
<tr>
<td></td>
<td>Use new media critically</td>
<td>Media literacy</td>
<td>.62</td>
<td>.58</td>
</tr>
<tr>
<td></td>
<td>Formulate information questions</td>
<td>Information literacy</td>
<td>.33</td>
<td>.49</td>
</tr>
<tr>
<td></td>
<td>Search relevant info in several ways</td>
<td>Information literacy</td>
<td>.74</td>
<td>.69</td>
</tr>
<tr>
<td></td>
<td>Select internet sources using relevant content criteria</td>
<td>Information literacy</td>
<td>.70</td>
<td>.68</td>
</tr>
<tr>
<td>2. Innovative thinking</td>
<td>Integrate information from internet in schoolwork</td>
<td>Information literacy</td>
<td>.75</td>
<td>.67</td>
</tr>
<tr>
<td>Variance explained: 7.3%</td>
<td>Take new steps to gain creative ideas</td>
<td>Creativity</td>
<td>.60</td>
<td>.46</td>
</tr>
<tr>
<td>Eigenvalue: 3.31</td>
<td>Study topics out of own interest</td>
<td>Creativity</td>
<td>.34</td>
<td>.45</td>
</tr>
<tr>
<td></td>
<td>Follow insights and intuition to gain original ideas</td>
<td>Creativity</td>
<td>.52</td>
<td>.48</td>
</tr>
<tr>
<td></td>
<td>Analyze unknown situations</td>
<td>Problem solving</td>
<td>.58</td>
<td>.43</td>
</tr>
<tr>
<td></td>
<td>Think of different ways to solve a problem</td>
<td>Problem solving</td>
<td>.86</td>
<td>.68</td>
</tr>
<tr>
<td></td>
<td>Explicate examples for different solutions</td>
<td>Problem solving</td>
<td>.86</td>
<td>.68</td>
</tr>
<tr>
<td></td>
<td>Find strategies to determine the best solution for a problem</td>
<td>Problem solving</td>
<td>.85</td>
<td>.67</td>
</tr>
<tr>
<td>3. Critical thinking and -communication</td>
<td>Understand each other’s opinion by asking questions</td>
<td>Critical Thinking</td>
<td>.53</td>
<td>.49</td>
</tr>
<tr>
<td>Variance explained: 4.7%</td>
<td>Compare information from different sources</td>
<td>Critical Thinking</td>
<td>.65</td>
<td>.49</td>
</tr>
<tr>
<td>Eigenvalue: 2.26</td>
<td>Formulate their own judgment or perspective</td>
<td>Critical Thinking</td>
<td>.82</td>
<td>.67</td>
</tr>
<tr>
<td></td>
<td>Support their own opinion with arguments</td>
<td>Critical Thinking</td>
<td>.87</td>
<td>.67</td>
</tr>
<tr>
<td></td>
<td>Convey the goal of messages on paper or orally</td>
<td>Communication</td>
<td>.61</td>
<td>.44</td>
</tr>
<tr>
<td></td>
<td>Participate in different communicative situation</td>
<td>Communication</td>
<td>.60</td>
<td>.52</td>
</tr>
<tr>
<td></td>
<td>Adjust a message to audience</td>
<td>Communication</td>
<td>.45</td>
<td>.50</td>
</tr>
<tr>
<td></td>
<td>Collaborate with students from different (social, cultural, ethnic) backgrounds</td>
<td>Socio-cultural competences</td>
<td>.62</td>
<td>.43</td>
</tr>
<tr>
<td>4. (Digital) citizenship</td>
<td>Understand there are several views on how to live and interact in society</td>
<td>Socio-cultural competences</td>
<td>.85</td>
<td>.75</td>
</tr>
<tr>
<td>Variance explained: 3.4%</td>
<td>How to express their feelings and opinions constructively</td>
<td>Socio-cultural competences</td>
<td>.73</td>
<td>.71</td>
</tr>
<tr>
<td>Eigenvalue: 1.79</td>
<td>Be aware of their responsibility in class, school and society at large</td>
<td>Socio-cultural competences</td>
<td>.69</td>
<td>.65</td>
</tr>
<tr>
<td></td>
<td>Understand the influence of media on society and themselves</td>
<td>Media literacy</td>
<td>.34</td>
<td>.60</td>
</tr>
<tr>
<td></td>
<td>Use new media critically</td>
<td>Media literacy</td>
<td>.32</td>
<td>.58</td>
</tr>
<tr>
<td>5. Self-regulated learning</td>
<td>Formulate own goals on assignments</td>
<td>Self-regulation</td>
<td>.50</td>
<td>.51</td>
</tr>
<tr>
<td>Variance explained: 2.24%</td>
<td>Reflect on their approach regarding planning and learning strategies</td>
<td>Self-regulation</td>
<td>.85</td>
<td>.73</td>
</tr>
<tr>
<td>Eigenvalue: 1.29</td>
<td>Adjust their approach or planning when needed</td>
<td>Self-regulation</td>
<td>.93</td>
<td>.79</td>
</tr>
<tr>
<td></td>
<td>Understand the responsibility for their own outcomes and consequences of their work</td>
<td>Self-regulation</td>
<td>.68</td>
<td>.55</td>
</tr>
<tr>
<td></td>
<td>How to motivate themselves to complete a large assignment</td>
<td>Self-regulation</td>
<td>.67</td>
<td>.61</td>
</tr>
</tbody>
</table>

(continued)
align with the categories of digital competence in the conceptual framework of P21 (Partnership for 21st century skills, 2015). It was, however, unexpected that two items for communication loaded on this factor. Still, this merely shows that teachers perceive that their activities to foster communication competences are currently integrated with ICT-related practices (Dede, 2010). It further demonstrates how teachers anticipate a changed conception of literacy, considering that students will rely more on ICT as information resources or as media for communication (Leu et al., 2004). In general, the fact that teachers' self-reported implementation of these classroom activities form a coherent construct, suggests that they perceive them as a practically coherent set of practices. Moreover, since digital literacy was the dimension that explained the largest share of variance in the concept of classroom activities for twenty-first century competences, this underlines its perceived priority status in the educational innovation.

Table 6. (Continued)

<table>
<thead>
<tr>
<th>Factor</th>
<th>Item</th>
<th>Original scale</th>
<th>Loading</th>
<th>( h^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. (Computer-Supported) Collaboration</td>
<td>Ask and give help in collaboration</td>
<td>Collaboration</td>
<td>.72</td>
<td>.59</td>
</tr>
<tr>
<td></td>
<td>Be open for each other’s ideas</td>
<td>Collaboration</td>
<td>.55</td>
<td>.62</td>
</tr>
<tr>
<td></td>
<td>Negotiate in teams on strategies to achieve a goal</td>
<td>Collaboration</td>
<td>.60</td>
<td>.59</td>
</tr>
<tr>
<td></td>
<td>Take responsibility as a group for the final outcome of collaborative work</td>
<td>Collaboration</td>
<td>.62</td>
<td>.55</td>
</tr>
<tr>
<td></td>
<td>Use digital technologies</td>
<td>ICT-skills</td>
<td>.32</td>
<td>.45</td>
</tr>
</tbody>
</table>

Note. Factor loadings <.30 are suppressed.

Table 7. Factor correlation matrix.

<table>
<thead>
<tr>
<th>Factor</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Digital literacy</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Innovative Thinking</td>
<td>.44</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Critical thinking and -communication</td>
<td>.64</td>
<td>.53</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. (Digital) citizenship</td>
<td>.42</td>
<td>.49</td>
<td>.59</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Self-regulated learning</td>
<td>.58</td>
<td>.63</td>
<td>.58</td>
<td>.52</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>6. (Computer-Supported) Collaboration</td>
<td>.36</td>
<td>.47</td>
<td>.45</td>
<td>.50</td>
<td>.56</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Table 8. Descriptive statistics for the six factors in twenty-first century competences survey (\( N = 2804 \)).

<table>
<thead>
<tr>
<th>Factor</th>
<th>M (SD) Primary education (( N = 805 ))</th>
<th>M (SD) Secondary education (( N = 1999 ))</th>
<th>Overall (( N = 2804 ))</th>
<th>Skewness</th>
<th>Kurtosis</th>
<th>Cronbach’s ( \alpha )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital literacy</td>
<td>2.43(.84)</td>
<td>2.50(.79)</td>
<td>2.48(.80)</td>
<td>.27</td>
<td>−.52</td>
<td>.92</td>
</tr>
<tr>
<td>Innovative thinking</td>
<td>2.83(.69)</td>
<td>2.75(.78)</td>
<td>2.77(.75)</td>
<td>.26</td>
<td>−.14</td>
<td>.88</td>
</tr>
<tr>
<td>Critical thinking and -communication</td>
<td>2.87(.73)</td>
<td>2.79(.82)</td>
<td>2.81(.80)</td>
<td>.06</td>
<td>−.36</td>
<td>.88</td>
</tr>
<tr>
<td>(Digital) Citizenship</td>
<td>3.10(.77)</td>
<td>2.76(.87)</td>
<td>2.86(.86)</td>
<td>.12</td>
<td>−.45</td>
<td>.85</td>
</tr>
<tr>
<td>Self-regulated learning</td>
<td>2.90(.83)</td>
<td>2.84(.84)</td>
<td>2.86 (.84)</td>
<td>.26</td>
<td>−.22</td>
<td>.89</td>
</tr>
<tr>
<td>(Computer-supported) collaboration</td>
<td>3.66(.70)</td>
<td>3.14(.80)</td>
<td>3.28(.80)</td>
<td>−.01</td>
<td>−.57</td>
<td>.85</td>
</tr>
<tr>
<td>Total</td>
<td>2.71(.63)</td>
<td>2.63(.65)</td>
<td>2.65(.65)</td>
<td>.27</td>
<td>−.23</td>
<td>.96</td>
</tr>
</tbody>
</table>
6.1.2. Innovative thinking
The seven items within this dimension either belong to the original scale of creativity or to the scale of problem solving (see Table 6). Several frameworks have incorporated these competences in overarching categories of twenty-first century competences, like learning to learn or thinking skills (see Table 1). However, problem solving has previously barely been interpreted in terms of innovation. Still, the concurrence of these classroom activities in teachers’ self-reports suggests that teachers perceive activities that foster problem solving and creativity as concurrent enterprises. The integration of these two competences is not only relevant for practice, yet aligns with theory as well. For example, it has been assumed that learning activities that encourage problem solving and creativity complement each other in the development of students’ innovative capabilities (Weisberg, 2006). Moreover, creativity as a twenty-first century learning goal has been conceptualized to not only target the novelty and the usefulness of students’ ideas, but also their suitability to approach a defined problem (Henriksen, Mishra, & Fisser, 2016). Thus, these theoretical understandings and the practical interpretation of teachers show that practices for problem solving and creativity may very well align in curricular guidelines.

6.1.3. Critical thinking and communication
The items that are incorporated in this dimension either indicate aspects of critical thinking or communication (see Table 6). Although none of the existing frameworks have related these competences (see Table 1), it is understandable how critical thinking and communication are connected when explicating their operationalization in the education context. First of all, classroom activities for critical thinking are mainly implemented in communicative- or social contexts (Ten Dam & Volman, 2004). More specifically, the expression of critical thinking relies upon communicative competences like the ability to debate, express informed opinions or to evaluate and respect the opinion of others (Volman & Ten Dam, 2015). Conversely, effective communication might bear a critical component. Especially in the digitalized world where large audiences from diverse backgrounds can be reached through various channels, being able to convey messages in a constructive way seems to require critical reflection (Hull, 2003). Hence, the results mainly substantiate how teachers perceive that the classroom activities for these competences can intersect.

6.1.4. (Digital) citizenship
All four items on the original scale of socio-cultural competences and two items on the scale for media literacy are included this dimension (see Table 6). Although socio-cultural competences and media literacy are not associated in the existing frameworks (see Table 1), it shows that teachers recognize how classroom activities that foster these competences are logically and practically interrelated. Initially, this dimension seems to represent activities for democratic citizenship, including activities that foster societal engagement or respect for diversity in perspectives (Ten Dam, Geijsel, Reumerman, & Ledoux, 2011). However, it also illustrates aspects of digital citizenship, as it targets responsibilities and etiquettes related to the use of new media (Ribble, Bailey, & Ross, 2004). Although digital citizenship includes a wider variety of characteristics, like health- or legal aspects (Ribble et al., 2004), the results at least demonstrate how teachers perceive that their activities for social and cultural competences bear digital connotations in
practice. This seems to indicate that teachers acknowledge social responsibility in a broad environment: in school, in society and on the web.

6.1.5. Self-regulated learning
This dimension comprises merely all five items on the scale of self-regulation (see Table 6). In other frameworks, this dimension in twenty-first century competences is described as initiative and entrepreneurship, operating autonomously, self-direction or prioritizing, planning and managing for results (see Table 1). In the context of education, these competences are generally conceptualized as self-regulated learning, which describes how students acquire learning strategies, understand how to apply them in several contexts and how to motivate themselves (Pintrich, 2000). This means that students can practice and develop self-regulatory competences in school, which they can transfer to their professional life (Pellegrino & Hilton, 2013). Based on the results, teachers perceive classroom activities that foster these competences to be coherent and, to some extent, distinct from other activities. This could be due to the fact that self-regulated learning has already been acknowledged as a learning objective in Dutch education policies of the 1990s (Blok, Oostdam, & Peetsma, 2006).

6.1.6. (Computer-supported) collaboration
The four items within this dimension capture the original scale of collaboration (see Table 6). Alternatively, some frameworks refer to this competence as teaming or interpersonal skills (see Table 1). In general, the results show that teachers agree that collaboration competences can be fostered by distinct activities. The only unexpected finding is that one item for ICT-skills loaded on this dimension (see Table 6). This suggests that teachers may understand collaboration as a specific learning outcome that can be partially facilitated through ICT-related practices (Arvaja et al., 2008). Still, a more hesitant conclusion on the relevance of ICT in the dimension of collaboration is appropriate, considering that it is informed by a sole item with a moderate loading.

6.2. The relative importance of the dimensions
Considering the differential proportions of explained variance for the different dimensions, teachers’ self-reported implementation of digital literacy and innovative thinking seems to be most fundamental in their perception of twenty-first century classroom activities. Although the large number of items within the dimension of digital literacy might account for its explanatory power, its ratio of explained variance to the number of items is disproportionately large compared to that of other factors. In addition, innovative thinking explains a larger share of variance than other factors that have a similar amount of items. This substantiates that the dimensions have a differential weight in teachers’ overall perception of the practices that foster twenty-first century competences. Still, this differential importance should be interpreted with some caution. The considerable interrelationships among the dimensions suggest that teachers perceive that less explanatory dimensions of classroom activities, like for collaboration or self-regulated learning, can support other dimensions that are more inherent to the innovation. This shows that teachers do not conceptualize or enact twenty-first century competences as disconnected classroom activities, but already have a more integrative conception of the curricular innovation.
Teachers typically indicated to spend the least attention to digital literacy and innovative thinking, despite the alleged importance of these dimensions for twenty-first century practices. This could be due to the fact that specifically the definitions and connotations of these dimensions are rather new and still subject of discussion (Coiro et al., 2014, Henriksen et al., 2016). Classroom activities that are less specific to twenty-first century competences, like collaboration and self-regulated learning, are more frequently implemented. These competences are already for two decades centralized in the Dutch education policy (Blok et al., 2006). This seems to indicate that teachers perceive to spend less time to competences that bear relatively novel connotations and that have not yet been clearly integrated into curricula.

6.3. Limitations

There are some limitations to this study that need to be recognized in the interpretation of the findings. First, the representativeness of the findings is important to consider. The sample includes a disproportionately small amount of females, primary-school teachers, teachers in pre-vocational tracks and teachers younger than 36 years old. Moreover, the significant overrepresentation of females and older teachers in attrition numbers might indicate their disagreement or disengagement with twenty-first century competences as formulated in the survey. Therefore, the given results might not typify the overall teaching population. Second, it should be taken into account that the items for each scale were presented in clusters. This means that the four items for creativity were presented as a group, followed by the four items of critical thinking, and so on. As the order of items is a potential source of bias (Rattray & Jones, 2007), the presentation of the items could have determined or at least influenced the composition of the dimensions. Third, the results are based on teachers self-reported classroom activities. Since such reports are susceptible to subjective validation, they represent teachers’ perception of their practices rather than the actual activities. Moreover, there are many other factors in the school context, like assessments, benchmarks or material resources that affect the implementation of twenty-first century competences. Although it was impossible to address all these factors or to capture actual practices, the data bear relevance for understanding teachers’ perceptions of their professional actions. Finally, it is important to keep in mind that the established factors are based on a restricted set of ideas on twenty-first century competences and their concomitant practices. Therefore, it has not been possible to include all relevant conceptualizations. For example, the items in the survey did not represent visual or procreative components in teaching digital literacy (Jones & Flannigan, 2006) or legal, commercial or health-related dimensions in digital citizenship (Ribble et al., 2004). Although these are just examples, it represents that there might be uncovered conceptualizations and practices that could extend our practical understanding of twenty-first century competences.

6.4. Implications for practice and research

The results of this study can be used as representations of teachers’ perceptions with regard to relevant and practically coherent dimensions in classroom activities that foster twenty-first century competences. Thus, the six identified dimensions could serve as input
for the development of curricula that align with teachers’ sense making of the educational innovation and that support their agency. In turn, this could contribute to the viability and quality of the curriculum implementation. Since dimensions that are not yet integrated into education policy are perceived to be less integrated into practice, including digital literacy and innovative thinking, these dimensions might deserve somewhat more considerate attention in curricula guidelines. Still, curriculum development is urged to take notice of the interdependence between the different dimensions of classroom activities. For example, curricula could present clusters of classroom activities for specific competences, like digital citizenship. In addition, linkages with other classroom activities that foster other competences may be explained. In order to maintain support of the educational sector, teachers and school leaders could be invited to reflect upon the feasibility and relevance of developed curricular guidelines for twenty-first century competences.

Furthermore, future research is encouraged to test the validity of the identified dimensions independent of their presentation of the survey. This would mean that confirmatory analyses could be conducted with the items in the different dimensions presented in a mixed order. To further generalize the outcomes, research is urged to examine whether the dimensions in classroom activities differ per education sector or teacher age group. Finally, research focused on objective indications of teachers’ twenty-first century classroom activities, for example, through observations or regulated logbooks, is encouraged to approximate a more comprehensive understanding of teachers’ actual enactment of twenty-first century competences and how these form coherent constructs.

7. Conclusion

This study adopted a secondary analysis of survey data to identify how teachers’ self-reported classroom activities could form dimensions in teaching twenty-first century competences. The results suggested six dimensions relevant to define classroom activities regarding twenty-first century competences: digital literacy, innovative thinking, critical thinking and communication, (digital) citizenship, self-regulated learning and (computer-supported) collaboration. Whereas their relative importance in describing classroom activities varies, it seems that teachers conceptualize and perceive their enactment of these dimensions comprehensively. The contents of these dimensions could help to formulate clear and practically viable definitions for twenty-first century competences, as they align with teachers’ self-perceived coherence of classroom activities. Thus, they can support teachers’ agency and sense making of the curricular reform. This could inform policy to improve the development of curricula that aim to foster twenty-first century competences in students.

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Disclosure statement

No potential conflict of interest was reported by the authors.
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