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Standardized school-leaving exam in mathematics: manifold effects on teaching, teacher cooperation and satisfaction

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The recent implementation of a standardized school-leaving exam (SSLE) in Austria enables research on the effects of this educational policy decision on mathematics teaching (use of tasks and digital tools) and on mathematics teachers (attitudes, cooperation, satisfaction and self-concept). An interview study with 10 teachers, each of whom prepared students several times for the traditional, individually designed as well as for the new, standardized school-leaving exam, reveals a multi-faceted picture. In particular, it shows that the SSLE as a steering instrument has great influence on the use of tasks in the classroom and has been able to advance the digitization of mathematics teaching within a short period of time. Cooperation among the teachers in the respective schools has clearly increased as a result of the SSLE, even though this is not perceived as unreservedly positive. Interestingly, the interviews did not reveal any evidence of harmful competition between teachers in a school regarding the performance of their students in the SSLE. While the study shows that teachers are basically positive about reforms and are willing to implement them, they also want changes to be well prepared, argued and communicated in time.

KEYWORDS

school-leaving exam, standardization, cooperation, satisfaction, technology use

1 Introduction

In the school year 2014/15, the standardized school-leaving examination (SSLE) was carried out at Austrian high schools for the first time (BMBWF, 2023). The tasks to be solved within the framework of the SSLE have since been given centrally and no longer chosen by the mathematics teacher of the respective class. Furthermore, in the course of this educational reform, the exam format of the school-leaving exam in mathematics was changed very significantly, and the use of digital tools was anchored as a mandatory component of the written exam. This development toward competence-oriented teaching with a focus on a change in perspective from input to output orientation was triggered by inadequate results in international comparative studies like PISA and TIMSS.

In the course of the development of the new concept for the school-leaving exam, basic mathematical competences were defined on the upper secondary level, which all Austrian high school graduates should master in order to secure basic mathematical knowledge and to create uniform conditions for all students and thus also follows international trends (Barrett-Tatum and Smith, 2018). While there are quite a lot of results in educational research on the influence of centralized testing on students (keyword teaching to the test), effects on the professional field of teachers have so far been underrepresented in research.

In view of the fundamental change in the exam system and the new role and responsibilities of teachers, it is obvious that this will also have an impact on teaching (use of tasks and digital tools) and several mathematics teachers' affective attributes (attitudes, cooperation, satisfaction, self-concept). This is where the present project sets in. While the specific results must of course be read and interpreted in the Austrian context, this study aims to shed light on mechanisms that – triggered by the implementation of a centralized examination – have an influence on the everyday working lives of teachers. A study like this can only be carried out at very specific times, namely when in-service teachers are familiar with both systems, have experienced them and can therefore compare them. In this respect, this provides an opportunity to explore mechanisms that begin to take shape when educational policy decisions are implemented.

2 Materials and methods

2.1 Literature review and theoretical considerations

An obvious question is whether centralized exams have an effect on students' performance. There are several studies on this, most of which show small positive effects (Alexander, 2000; Jürges and Schneider, 2010). But that is explicitly not the subject of this article.

If one leaves this focus on performance and turns primarily to aspects of teacher practise and satisfaction that are related to the introduction of centralized testing, there is a lack of data. In this context, the dissertation by Singer (2015) is worth mentioning, for it was able to prove for the Austrian context that SSLE tasks, which were basically designed as exam tasks, are also used in the classroom extensively, and there also for developing competence (Weinert, 2001). However, this study was conducted at the same time as the first round of the SSLE (2014/15); proof of the sustainability of this result is still pending and is part of the present study. However, there are some studies in the international context that also have demonstrated a trend toward 'teaching to the test' in central exams (Bell, 1994; Firestone et al., 2000; Cheng and Curtis, 2004; Jäger et al., 2012).

As far as cooperation among teachers is concerned, Singer (2015) was able to show that during the transition phase to the SSLE, content-related discussions among and material exchange between teachers was very intensive. Because teacher cooperation is an adaptive, complex system that evolves through individual processes but also through interaction with external stakeholders and systems (Yuan et al., 2018), it remains to be explored whether this effect is stable over time. Appius (2012) showed that the introduction of the central school-leaving exam in Germany has a favorable effect on the intensity of cooperation between teachers but is not experienced as relieving. In particular, new stress factors for teachers emerge through standardization and it is more obvious to compare one's own stress situation with those of colleagues. In this context, there are empirical findings that injustice and sense of workload are often causes of dissatisfaction and aggression in teacher teams (Sasson and Somech, 2015). Professional self-concept is also influenced by standardization. In this respect, Stone-Johnson (2014) was able to show that older teachers suffer more from being restricted in their freedom by standardization than younger teachers. The latter see the corresponding changes as part of their work. A study among English teachers revealed that teacher self-efficacy was one of the direct predictors of work engagement (Heng and Chu, 2023).

However, there are no comprehensive findings in the literature on how teachers react to the implementation of central exams in mathematics, what consequences can be expected for teaching and digitization, how cooperation but also competitive thinking between teachers develops in the long term, or how teacher satisfaction changes as a result of such a reform. This explains the focus on the situation in Austria, where the introduction of the SSLE 8 years ago can be used as an opportunity to clarify these issues.

Cooperation between teachers can be described and analyzed with the help of social interdependence theory. Social interdependence distinguishes between cooperative, competitive, and individualistic efforts (Johnson and Johnson, 2009). Cooperative efforts tend to lead to better performance, more positive relationships and greater mental health compared to competitive and individualistic efforts (Johnson and Johnson, 2003). According to this theory, there are five basic elements that promote cooperation and functioning collaboration: positive interdependence, individual accountability, facilitative interaction, appropriate use of social skills, and group work. We will use this theory to allocate teachers' statements in the interviews (Johnson and Johnson, 2008). Mora-Ruano et al. (2018) were able to show that the higher the level of education in a school, the less collaboration between teachers takes place. This is relevant for the present study, as the SSLE could possibly strengthen cooperation.

One of the aims of the SSLE is to promote the digitization of mathematics education (see the next section). Ruthven and Hennessy (2002), in an interview study with teachers, identified key factors for enhancing the use of digital tools: enhancing ambience, assist tinkering, facilitate routine and accentuate features. However, there is a lack of findings on how this can also be promoted by educational policy imperatives. Indeed, teacher beliefs play a crucial role here (Pierce and Ball, 2009; Drijvers et al., 2010; Drijvers, 2013; Ertmer et al., 2015; Humble and Mozelius, 2023). Scales to capture teachers' beliefs about the use of technology in mathematics education were developed by Thurm (2020). Thurm and Barzel (2022) provide an overview of the literature on different modes of technology use.

2.2 Description of the changes to the Austrian school-leaving exam

In order to make clear the differences between the 'traditional' school-leaving exam and the SSLE, which was introduced at Austrian high schools in 2014/15, we will now look at these two exam systems in detail.

In the traditional form, the written school-leaving exam was designed by the teacher of the respective class. It had to consist of four to six tasks that had to be solved independently of one another. The tasks were not to be limited to calculations, but were also to contribute to argumentation, representation, and interpretation as well as to the application of mathematics in non-mathematical areas. An electronic calculator, a formula booklet and a normal distribution table were permitted as aids. The chosen exam tasks were sent to the responsible education authority, where they were checked and, if applicable, approved. Due to the school-leaving exam being individually designed for each class, a nationwide comparability could not be guaranteed, which led to the call for a central school-leaving exam.

The goals of the reform were, among other things, a standardization of the basic mathematical competences to be acquired, extensive objectivity through standardized tasks, an improved informative value of the exam and the guarantee of the ability to study at university (BMBWF, 2023). In addition, more emphasis is placed on the use of technological tools by allowing higher level technology (such as GeoGebra or graphics calculators) without restriction in the SSLE.

The SSLE in mathematics has been organized in two parts since its introduction, but the structure of the exam and the form of processing have changed over time. From 2015 to 2018, the two parts were printed in two separate booklets. First, the students were handed out the booklet with 24 so-called Type 1 tasks. After 120 min, this booklet was collected and they received the second booklet with four Type 2 tasks, for which they had 150 min to complete. After gradual adaptations in 2019 and 2020, which are not explained in detail here, the SSLE in mathematics has the following structure since the 2021 exam date: The task booklet contains 24 Type 1 tasks, one Type 2 task with reduced context and three Type 2 tasks, each with at least two sub-tasks, which in turn each have at least one instruction. Type 1 tasks test a single basic competence. There are different permissible task formats for this purpose, such as multiple choice, matching format, cloze text and (semi-)open format. To solve tasks of type 2, several basic competences have to be combined. Type 2 tasks with a reduced context are linguistically simpler and consist of four independent subtasks (BMBWF, 2023). Basic competences are considered to be fundamental mathematical skills and abilities that should be available to students in the long term. A basic competency catalog has been developed for the SSLE, which is divided into the following four subject areas:

- Algebra and geometry
- Functional dependences
- Analysis
- Probability and statistics

This catalog, which is oriented toward the curriculum, contains all those competences that must be taught in mathematics lessons in any case, but it does not cover the entire curriculum. However, all other competences specified in the curriculum should also find place in the lessons. The tasks for the SSLE are created centrally and sent to the schools by the Austrian Federal Ministry of Education, Science and Research (BMBWF). Furthermore, a correction and grading key is made available for the teachers, because the exams have to be corrected and assessed by the respective teachers themselves. Further adaptations of the SSLE are already planned for the coming years, such as a technology-free part from 2030/31.

2.3 Research questions

The aim of the present study is to investigate aspects of teaching and teacher attitudes that were and will be influenced by the introduction of the SSLE. Qualitative, structured interviews were conducted with high school mathematics teachers, covering five sets of questions. Topics are the teachers' attitude toward SSLE, lesson content and use of tasks, use of technology, teacher cooperation as well as satisfaction of mathematics teachers. We divide the main research question 'To what extent has mathematics teaching and teachers' attitudes in high schools been influenced by the introduction of the SSLE?' into six subquestions:

- How was the introduction of the SSLE experienced by mathematics teachers and what are their attitudes toward the goals intended by this reform?
- How do mathematics teachers design their lessons in terms of the selection of lesson content and the use of tasks and what changes has the introduction of the SSLE revealed?
- How do teachers design the use of digital tools in mathematics lessons and to what extent did the introduction of the SSLE influence this use?
- In what way do mathematics teachers cooperate and how has teacher cooperation changed or developed since the introduction of the SSLE?
- What effect does the introduction of the SSLE have on mathematics teaching?
- To what extent has the introduction of the SSLE influenced teacher satisfaction?

2.4 Data collection tool

Since teachers' experiences and motivations for action are at the centre of the research questions mentioned above, and cultural conditions and personal attitudes also play a role, we resort to a qualitative research approach. In the present case, guided interviews are well suited to capture teachers' attitudes and perceptions about changes due to the redesign of the school-leaving exam. The interaction between the interviewer and the interviewees leads to a communicative process that is characterized by a practical and action-oriented approach (Gubrium and Holstein, 2009). The interviewed teachers are encouraged by the personal situation to be authentic, their answers are in a sense directly checked for consistency, and the fact that no predefined answer options are available, but rather differentiated questions are asked, also avoids hidden normativity.

For this purpose, a guideline was created, beginning with introductory questions such as gender, years of teaching experience, number of school-leaving classes taught before and after the introduction of the SSLE. This was followed by prompts on the six research questions described above (attitudes toward the SSLE, lesson content and task use, use of technology, cooperation, teaching and satisfaction), which resulted from the literature review, already existing research results and central aspects concerning the SSLE (see Supplementary Appendix 1). In the course of the interviews, however, some space opened up for relevant follow-up and *ad hoc* questions, which can serve both to confirm existing research findings and to gain new insights, thus enabling a mixed deductive-inductive approach, as described by Hussy et al. (2010).

Of course, there are always potential biases in interview studies, such as socially desirable answers or cautious expression of opinion due to concerns about the publication of controversial views. This was countered by a pleasant one-on-one interview situation, a sufficient duration of the interviews to familiarize the participants with the situation and the assurance of anonymity in the evaluation.

In qualitative studies, a limitation always might be the generalisability of the results. The available, extensive data material with its diverse, reflective answers in the interviews, suggests a complete picture regarding relevant aspects. It shows a satisfactory saturation with regard to the codes that occurred (Guest et al., 2006). For quantitative statements, a questionnaire study could provide further insights.

2.5 Sample group and data collection

Permission to conduct the study was sought from the relevant education authority in November 2022, and interviews were then conducted with a total of 10 teachers from March to May 2023. These were mathematics teachers who taught mathematics on upper secondary level both before and after the introduction of the SSLE and prepared them for the school leaving exam. High school teachers with different levels of experience (13 to 36 years of teaching experience) were asked to take part in the interviews. Participation was voluntary, but all teachers approached agreed to participate. The gender ratio roughly corresponds to that in the population of all Austrian high school maths teachers (approx. 2 thirds female). In the selection process, a balance was ensured with regard to the specializations of certain schools (entire secondary level, only upper secondary level, science focus, etc.). The interviews were conducted partly in presence, partly via video conference. They were each recorded with two recording systems (mobile phone, zoom recording function, dictaphone) and fully transcribed. Table 1 shows a list of all interview partners including meta-information such as gender, teaching experience and duration of the interview.

2.6 Data analysis

For the data evaluation, the method of structuring qualitative content analysis according to Mayring (2022) was used, in which categories are deductively established and the data are structured accordingly. In the course of the qualitative data analysis, which was carried out with the help of MAXQDA software, some statements of the interviewees were identified that could not be assigned to any of the deductively formed categories. These data served – as explained by Mayring (2022) – a category expansion in which the category system is inductively supplemented with relevant aspects in the material that do not fit into any of the deductive categories. Definitions and anchor examples for these categories were then added. The category system with all codes can be found in Supplementary Appendix 2. The coding of the data was carried out by the second author and checked by the first author as part of a peer-debriefing process. For this purpose, complete transcripts were first prepared for all 10 interviews. The data material was then categorised into coding units. Care was taken to ensure that individual coding units only addressed one aspect of the coding guide (see codes in Supplementary Appendix 2) so that a clear assignment could be made. The length of the coding units ranged from one to several sentences. Coding units that could not initially be categorised were used to generate new codes. This inductive category formation was already completed after coding the first three interviews, i.e., the codes for the remaining seven interviews did not need to be changed or supplemented any further.

The interviews were so extensive in terms of time and density of information that only aspects that were either mentioned by many teachers or where there were clearly different perspectives can be reported here.

3 Results

The structure of this section is based on the category and code system mentioned above (see Supplementary Appendix 2), whereby the codes are either dealt with individually, or in combination with each other.

3.1 Research question 1: attitudes toward SSLE (codes C1 – C3)

Initial information about an upcoming implementation of a SSLE in mathematics was perceived very differently by the interviewees. More than half of the teachers said they were very open to innovation, as they hoped for more equity through standardization of the exam

TABLE 1 Information about the interviewees.

Teacher no.	Gender (m/f/d)	Teaching experience in years	No. of classes taught, with 'traditional' school-leaving exam	Number of classes taught, with SSLE	Interview length (h:min:sec)
T01	m	13	1–5	5	1:15:25
T02	f	35	> 10	6–10	0:52:58
T03	f	34	1–5	5	1:19:42
T04	m	36	6–10	3	1:53:35
T05	f	22	1–5	3	1:30:27
T06	f	23	1–5	1	1:01:02
T07	f	34	6–10	5	0:58:20
T08	m	30	6–10	5	0:47:22
T09	f	27	1–5	5	0:48:06
T10	f	35	1–5	3	1:08:33

(T01, T05, T06, T07, T08, and T10). Some of the interviewees attended teacher training courses and followed the development of the SSLE very closely (T07, T08, T09, and T10).

For some interviewees, scepticism (T04 and T09), fear and anxiety (T02) and even panic (T09) were triggered. The scepticism referred to the idea that all students in Austria would have to solve the same tasks and that teachers would have to teach in a similar way, so that personal preferences would no longer be possible. T02 and T09 were concerned that they could not adequately prepare students for an unknown exam. This was made even more difficult by the fact that the education authorities sometimes provided information at too short notice (T03, T06, and T09).

Almost unanimously, the standardization is emphasized as an advantage, which, compared to the traditional school-leaving exam, makes it impossible to give the students concrete hints about the exam tasks (T01, T05, T06, T07, T08, T09, and T10). In connection with this, a stronger orientation toward mathematical understanding and the promotion of the students' ability to think independently is emphasized, whereas recipe-like and procedural activities have decreased (T01, T04, T06, T07, T09, and T10). In addition, the teacher's role has changed to that of a trainer who pursues a common goal with the students [T05, T07, T09, and T10, Schoenfeld (1988) and Fey (1989)].

It is perceived as a disadvantage that teachers have hardly any possibilities for setting their own priorities and that specific interests of the students can no longer be addressed (T02, T04, T05, T08, and T09). Here a connection can be made with Stone-Johnson (2014), who showed that – at least for older teachers – standardization leads to a perceived restriction of freedom. This is also justified by the fact that teaching and training the basic competences prescribed for the SSLE is very time-consuming (T01, T05, T08, and T09).

3.2 Research question 2: teaching content and task use (codes C4 – C10)

Most teachers still try to follow the compulsory curriculum, even though the basic competences for SSLE are only a subset of it (T01, T05, T06, T07, and T09). However, they agree to omit some topics from the curriculum if necessary. Others limit their teaching to SSLE content from the outset due to time constraints (T03, T04). Interestingly, the introduction of the SSLE has brought content areas such as stochastics and functions more into focus (T03, T04, and T06).

While the textbook continues to be used extensively in the classroom, teachers also use other sources for the selection of tasks for classwork, such as problems from previous SSLE dates (this confirms Singer, 2015), learning platforms and tasks from colleagues (T01, T03, T04, T05, T06, T07, and T09).

The use of Type 1 tasks in the format of the SSLE takes up a large part of the teaching time for the majority of interviewees (T02, T03, T04, T05, T06, T07, T08, and T09), especially during practice phases and homework exercises. The fragmentation of knowledge described by Au (2007), in which content is treated in small, separable chunks, can thus be observed here. Strategies for dealing with special SSLE task formats (multiple choice, cloze, etc.) are also explicitly addressed in class (T05, T06, T08, and T09). The more complex Type 2 tasks are used in class by most teachers, but to a much lesser extent than Type 1 tasks (T01, T02, T06, T07, T09, and T10).

3.3 Research question 3: use of technology (codes C11 – C17)

In all classes of the interviewees, the mathematics software GeoGebra has been used in lessons for at least four years before the SSLE; in T09's class, graphics calculators are also used. Most cite SSLE as the main reason for this (T01, T02, T04, T05, T06, and T07). On average, teachers use technology in class once a week (which confirms findings by Dorner and Ableitinger, 2022), although the way in which it is used varies widely (from student-centered periods to teacher demonstration periods).

Independent of the specific functions of technology to address the SSLE, technology is used for visualization (T01, T02, T03, T04, T07, T09, and T10, multiple representations in Thurm, 2020, Thurm and Barzel, 2022), experimental activities [T05, T08, and T10, discovery learning in Thurm (2020) and Hoyles et al. (2013)] and outsourcing procedural activities (T01, T02, T05, and T06). Conversely, some fear the loss of technology-free procedural skills among students [T01, T04, T05, T07, and T09, skill loss in Thurm (2020)]. Some therefore initially teach technology-free and only allow GeoGebra once the procedural skills have been developed [T06, T08, T09, and T10, prior mastery of mathematics by hand in Thurm (2020)]. In this context, there are divided opinions about the planned change to a technology-free part of the SSLE. While some teachers are rather skeptical, especially due to a lack of information regarding the concrete implementation (T02, T06, T07, and T09), others are basically positive about this reform (T01, T03, T04, T05, and T08).

3.4 Research question 4: cooperation (codes C18 – C23)

Most teachers noticed increased cooperation caused by the introduction of the SSLE (T01, T02, T03, T04, T07, and T09). The reason given is the common goal of preparing all students for the SSLE in the best possible way, under the same, centrally specified guidelines. Cooperation takes place primarily in the teaching team of the classes that are completing the SSLE in the relevant year. While T01, T04, and T07 report extensive cooperation (cooperative effort, Johnson and Johnson, 2009), T03, T05, T06, T08, and T09 only work with colleagues with whom cooperation works well and profitably (positive interdependence, Johnson and Johnson, 2008). Only T02 and T10, however, continue to work independently (individualistic effort, Johnson and Johnson, 2009).

The cooperation concerns the exchange of teaching material, the selection of tasks for written exams, didactic advice and the joint correction of exams and also the SSLE.

These forms of cooperation are fundamentally seen as relief and enrichment (T01, T03, T04, T05, T06, T08, and T09, Johnson and Johnson, 2003). Disadvantages and burdens arise when very different working styles come together and individual accountability is missing (T03, T05, and T09, Johnson and Johnson, 2008), personal differences arise (T01, T03, and T05) or when the cooperation is very time-intensive (T01, T03, T04, and T07). Interestingly, the teachers do not see any competition (Johnson and Johnson, 2009) among each other when it comes to

their students' performance on the SSLE. However, sometimes competition exists between different schools (T02 and T06).

3.5 Research question 5: impact on teaching activity (C24 – C27)

Through the SSLE, activities such as interpreting and justifying have become more important for teaching (T04 and T05). In general, there is a shift toward competence orientation and especially toward the basic competences of the SSLE (T01, T02, T07, T08, and T09). In this context, T01 and T10 feel burdened by having to justify to the students why content is being taught that is in the curriculum but not relevant to the SSLE.

Many feel that their freedom of action is restricted in terms of content priorities, flexibility and responding to special student needs (T01, T02, T03, T04, T05, T06, and T07). Conversely, the SSLE is also perceived as an opportunity to bring students to the same level (T08 and T09). The increased use of technology through the SSLE is also seen as a new opportunity for teaching (T07, T08, and T10).

As mentioned before, the teacher role has changed for some in that, at least before the SSLE, the teacher is no longer seen as an examiner but as a trainer (Schoenfeld, 1988; Fey, 1989). The relationship with the students has changed positively as a result (T05, T07, T09, and T10).

3.6 Research question 6: satisfaction (codes C28 – C31)

At the beginning, some teachers felt very challenged or even overwhelmed by the many changes, e.g., task formats, new assessment system or the use of digital tools (T03, T05, T07, and T08). For T01, for example, the amount of preparation and the responsibility to find or develop suitable practice material has increased, especially for students with ambitions for good grades. Some describe the compilation of exams as 'terribly time-consuming' and very error-prone in terms of typing errors because the task formats (e.g., multiple choice) require great accuracy. The time burden has thus clearly increased due to the changed exam design (T01, T03, T04, T05, and T06).

In addition, on the one hand, pressure to perform is perceived, which for T03, T05 and T09 was only noticeable in the first years of the SSLE, but still exists for T02 and T06. On the other hand, most teachers feel time pressure to work on all contents and competences relevant for the SSLE (T01, T03, T04, T05, T06, T07, T08, and T09).

Some interviewees mentioned their students' good results in exams and SSLE in recent years as a factor of satisfaction (T01, T05, and T07). The interviewees consistently state that they are satisfied or very satisfied with the cooperation with their colleagues, whereby T03 and T07 report that it depends on the respective colleagues.

Basically, the central requirements regarding SSLE are seen pragmatically, they have come to terms with them (T03, T04, T05, and T08). T06 states that she is satisfied in that the central requirements have developed further and thus improved since the beginning of the SSLE. Specifically, a change in the assessment system and the shortening of texts in the Type 2 tasks are mentioned (T06, T07, and T08).

However, changes are also viewed critically. T02 and T05 complain about the short-term nature and immaturity of some changes. T01 mentions regular paradigm shifts that cause him a certain frustration. In this context, T07 calls for solid, well thought-out planning. Critical remarks are also made about a decline in the level of requirements and SSLE tasks over the last few years (T06, T08, T09, and T10) as well as a lack of consistency in terms of curriculum content and exam content in the SSLE (T01). This confirms findings from the literature that curriculum content is narrowed to tested content (Bell, 1994; Cheng and Curtis, 2004; Au, 2007).

4 Discussion and implications

It is particularly noteworthy that due to the requirements of the SSLE, the legally prescribed curriculum can no longer be fully adhered to by most teachers. Conversely, certain subject areas such as stochastics have gained in importance in the classroom due to the SSLE. This steering function of the SSLE even carries through to the concrete selection of tasks for class work and the training of strategies for closed task formats (Abrams et al., 2003), sometimes even many years before students have to complete the SSLE.

Technology, which for years before had only slowly found its way into the classroom, was strengthened by the SSLE within a very short time and became a significant element of teaching. Even though the loss of technology-free procedural skills could be empirically refuted (Dorner and Ableitinger, 2022), this fear exists among teachers and also on the part of educational authorities. This has led, among other things, to the fact that there will be a technology-free part at the SSLE from 2028 onwards.

The feeling of satisfaction is described in a very differentiated way in the interviews. This may be an indication that social desirability did not play a role for the teachers in their answers. Certain aspects, such as cooperation, task selection, implementation of reforms by the education authorities, are critically examined, although many positive developments are also perceived. It can be seen from the data that the cooperation between teachers triggered by the SSLE (Singer, 2015) is relatively strong even several years after its introduction, while competition among teachers of the same school does not seem to play an important role.

The importance of the central exams as a steering instrument for teaching must not be underestimated. This is impressively confirmed by the available data and supports results from the literature (Abrams et al., 2003). This concerns concrete teaching practice, the relevance of specific teaching contents (in the present project, for example, the changed importance of stochastics and functions) but also cooperation among teachers. Educational authorities thus have an instrument at their disposal to implement reforms (such as advancing digitization) quickly and efficiently. This result has relevance beyond the national context for education systems in other countries.

If reforms are announced well in advance, well thought out and carefully implemented, this increases the satisfaction of the teachers who have to implement these reforms. This is evident in many places in the data material. However, in practise this is sometimes countered by the need for quick political decisions.

The results also show that the teachers surveyed are in principle open to innovation and have responded positively to the reforms. About 8 years after the introduction of the SSLE, the teachers have already come to terms well with the framework conditions, changed teaching conditions, the new task and exam culture. Even though initial scepticism and dissatisfaction with the way of implementation could be perceived, the teachers interviewed reacted flexibly to necessary changes and always keeping the students in mind. This shows that changes in the school system can be implemented professionally within a few years – a finding that is also encouraging for future reforms.

The strengths of the present study include the in-depth exploration of teachers' perspectives and the comprehensive analysis of SSLE's impact on teaching practices and teachers' attitudes. The detail of the interviews and the structured analysis can ensure a comprehensive inventory. The special educational policy situation in Austria was used to examine the effects of an educational policy decision at an ideal time (around 8 years after the introduction of the SSLE). The teachers interviewed had known the two school-leaving exam systems long enough to be able to identify substantial differences and to be able to validly assess the effects of the SSLE. A novelty is that, as is often the case, the impact on the students' performance was not taken into account, but rather the perspective of the teachers with regard to teaching practices and cooperation and satisfaction.

4.1 Limitations

In order to minimize researcher subjectivity in interpreting the data, peer debriefing was carried out, albeit by the first author of the study. An additional interpretation of the data by an external peer was not possible due to the volume of data.

In order to avoid the social desirability of the answers in the interviews, the teachers were guaranteed anonymity and an interview setting was chosen that illuminated the research questions from different perspectives. The interviewer offered enough opportunities to speak and enough time so that the interviewees could make themselves understood. The sample size of 10 people seems small at first glance, but data analysis revealed saturation with regard to the aspects mentioned.

The restriction to Austrian high school teachers arises from the scope of the study, in which the effects of the SSLE were to be examined. Of course, there are some peculiarities in this national context that limit generalization to other contexts. Above all, the so far unrestricted use of technology in the SSLE and the special structure of the tasks in the SSLE should be mentioned. However, fundamental mechanisms that are not directly related to these specifics (perceived freedom, change in cooperation, teaching to the test effects) can also be transferred to other educational contexts.

When it comes to the interviewees, a possible age bias must be mentioned here. For the reasons mentioned, only teachers who had at least 13 years of teaching experience were interviewed so that they could make a comparison with the traditional school-leaving exam. Voluntary participation in the study can also have an influence on the results. However, we are quite satisfied with the variety of answers and the abundance of critical perspectives.

4.2 Future research

In addition to the interviews done in this study, field observations and the collection and analysis of documents (e.g., communication when compiling exercise material or exams) would be interesting sources of data with which the statements in the interviews could be validated. In addition, member checking, i.e., the interviewees discussing and, if necessary, supplementing or clarifying the collected data, could increase the validity of the results.

Further research projects could deal with the changes in teaching practices caused by the SSLE. For example, the impact of the planned technology-free parts could be examined. Furthermore, the research could be broadened to include other subjects that are assessed in the SSLE (especially the language subjects German and English). It would be interesting to see to what extent the results presented here are specific to mathematics.

A comparison with other educational systems through comparative analyses would be desirable. However, appropriate framework conditions (recent implementation of standardized tests) would have to be in place for this to be conducted.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Bildungsdirektion Niederösterreich. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

CA: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. JG: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2024.1407441/full#supplementary-material

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