

Übersicht der deutschsprachigen Artikel über die Integration von Taschenrechnern im Mathematikunterricht 2000-2008



Raja HEROLD,
Bärbel BARZEL

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Preface (Vorwort)

An overview over the current state of research reports and ongoing projects about the integration of graphic tools and computer algebra in mathematics teaching was the aim of this bibliography report. To understand the German situation in this field it is helpful to give a glimpse view on historical specifics in Germany.

Graphic calculators (GC) and computer algebra systems (CAS) in mathematics education - there used to be two different ways of facing these new technologies when looking at different countries (Barzel 2006). On one hand, the development went from scientific calculators towards GCs until CAS was finally reached. This way was mainly broken by the USA, Australia and in Europe, the UK, Netherlands, all Scandinavian countries as well as the eastern German counties. In the newly-formed German states the GC is an inherent part since the 1990's. Long-term studies started, such as Hentschel/ Pruzina (1995), in different counties and analysed the integration of a GC from grade 9 until A-levels from 1991 onwards. This way, going from scientific calculators to GC and just then to CAS, is much more straightforward for the teachers then going from the scientific calculator directly to a CAS. This second way was mainly broken by Austria, Switzerland and the West German counties. It is more difficult for the teachers to integrate the graphical abilities of the calculator as well as the algebraic functions at the same time than one after another.

According to Weigand (2006) the discussion of the importance of CAS in maths classes can be divided into three main phases. The first phase began in 1988 when the CAS "Derive" was introduced on "personal computers". Lots of discussions followed arguing about the meaning of basic mathematical skills when knowledge and skills could be passed from the head to the technology. That way a lot of complicated calculations such as polynomial long division, trigonometric calculations or transformation of terms could be facilitated. Unfortunately, there was very little research done in this time.

The second phase started in December 1998 when the first handheld calculator TI-92 was introduced. Suddenly, it was no more necessary to go to the computer lab. Pupils could just take their calculator wherever they went. The discussion of how content and examination in maths classes should be changed started. Many suggestions of lesson designs were published by teachers and also first research projects were carried out.

In the third and last phase which started at the beginning of the century the awareness appears along that GC and CAS only achieved partial of acceptance. Weigand names four different, possible reasons for the non-acceptance in Germany:

- 1) teachers' attitudes: lack of familiarity with the tool, sorrow of losing important, mathematical basic skills, great importance to the traditional "paper-pencil-mathematics"
- 2) syllabuses and curricula: lack of integration of handheld calculators into the existing syllabuses, lack of change of learning content in respect of the use of handheld calculators
- 3) institutional demands: problem of various designs, fast change of versions, high price and social balance

- 4) construction of the tool: complicated handling, insufficient resolution of the screen, absence of development towards a pedagogical tool, high price, different types

Unfortunately, we could not include all existing German publications in this field because many of them were published already in the early 1990's. There have been esp. reports about various official projects initiated and organized by ministries of education in German counties such as Saxony, Baden-Wuerttemberg, Lower Saxony, North Rhine-Westfalia, Saxony Anhalt and Thuringia. These reports were published and disseminated by the local ministries or their institutes for teaching training.

The focus of this bibliography report is on official publications after the year 2000 and the ones that were not explicitly linked to a county government.

The main aim of this report is to give an overview of the existing researches concerning the integration of technology into mathematics education. We, basically, divided our report into four main parts. First, we explain the design of the chapters. In the second part, we list all relevant researches just to give an overview. The third part presents a summary and an analysis of all included projects. As there are different kinds of researches concerning the integration of technology in maths classes, we subdivided this chapter into four sections. There is first of all, research projects which means that these ones have already finished and are serious researches. The following part presents research projects still in progress and where we can only present first results. We are looking forward to the final results. The third section includes case studies and projects without a clear research design, mainly just focussing on few lessons or special short-time sequences. In the fourth part of the third chapter, we give a list of the lately published resources for maths lessons using CAS. All of them are designed and tried at school, so they base on experience.

Beside a lot of papers concerning studies we have involved two position papers. One of these is by Schneider/Peschek (2002) that presents ideas and aspects for a theoretical framework coming from a communication theory (i.e. Fischer 2000). Schneider and Peschek declare the calculator an expert. Hence, the use of a graphic calculator is the training of communication with an expert.

Another position paper is published by Barzel (2004) discussing the question whether integration of new media and opening up of processes in teaching and learning mathematics presuppose each other. She differentiates "new learning" into two main branches. First, the "interior method" is mentioned, saying that the teacher could open up the task. Beside, there is the "exterior method" with means that the way of teaching, the classroom organisation could be disclosed.

Finally, we want to, of course, thank all authors who helped us to find the relevant papers and checked our summary for their own publications. Additionally, our thanks go to Texas Instruments for giving us the opportunity to write this report.

1) Methodology (Methodologie)

Article	Publication	Type of study	Duration	Technology used	State	Methodology/ Instruments
Barzel, 2006	Dissertation	Research Project	two years (from 2002 to 2004)	TI-92, CAS on PC such as Derive and Maple	Study finished	Quantitative and qualitative research: video recording, students' notes, interviews, post test, survey
Barzel, Möller, 2001	Article	Case study	Two lessons (90 min)	TI-92	Study finished	Qualitative research: video recording, questionnaire, documentation, observation, explanation
Bichler, Weigand, 2008	Article	Research Project	eight years (from 2003 to 2011)	TI-Voyage 200, TI-Nspire CAS	Still in progress	Qualitative and quantitative research: pre- and post test, test describing the way of finding solutions, survey, questionnaire, professional adjustment
Bruder, 2008	Article	Research Project	two years (from 2005 to 2007)	TI-Voyage 200, TI-Nspire CAS, TI-84 Plus	Study finished	Qualitative and quantitative research: Pre- and post test, surveys, records of the lessons
Bruder, Ingelmann, 2007	Article	Research project	five years (from 2005 to 2010)	TI-Voyage 200	Still in progress	Qualitative and quantitative research: record of each lesson, survey, pre- and post test, analysis of students' work and the designed material

Bruder, 2006	article	Case study	six months (from February 2005 to July 2005)	TI-Voyage 200	Study finished	Qualitative research: Survey, documentation, portfolios
Hußmann, Laakmann, 2008	Dissertation, master degree	Research Project	two years (from 2006 to 2008)	TI-Nspire	Still in progress	Qualitative research: Lab-study, video recorded lessons, products from students, interviews, reports, observation forms
Peschek, Schneider, 2007	Comment	Case study	One year (2006/2007)	Handheld and computer-version of TI-Nspire	Study finished	Qualitative research: documentation, reports, survey, portfolios
Schmidt, 2002	Article	Survey	spring 2001	N/A	Study finished	Qualitative research: survey
Schneider, 2002	Book (postdoctoral studies)	Research project	one year (1997/1998), was extended to 3 years	TI-92	Study finished	Qualitative research: two sequences of lessons and the designed material
Weigand, 2006	Article	Research project	one year (2003/2004)	TI-Voyage 200	Study finished	Quantitative and qualitative research: Pre- and post test, questionnaire, record of each lesson
Weigand, Weller, 2001	Article	Case study	24 maths lessons	CAS on PC such as Derive and Mathplus	Study finished	Quantitative research: Computer protocols

2) List of Researches since 2000 (Liste von Studien seit 2000)

BARZEL, BÄRBEL (2006). MUKI – Mathematikunterricht zwischen Konstruktion und Instruktion, Evaluation einer Lernwerkstatt mit integriertem Rechnereinsatz. Dissertation. Universität Duisburg-Essen

BARZEL, BÄRBEL; MÖLLER, REGINA (2001). About the use of TI-92 for an open learning approach to power functions. A teaching study, ZDM, Zentralbl. Didakt. Math. 33, No. 1, 1-5

BICHLER, E.; WEIGAND, H.-G., Evaluation des Modellversuchs "Medienintegration im Mathematikunterricht - M3" - im Schuljahr 2006/07, TI-Nachrichten - Sonderausgabe Forschung, 2008, 14-15

BRUDER, REGINA (2008). TIM – Ein zweijähriger Modellversuch zum Einsatz von Taschencomputern ab Klasse 7, Technische Universität Darmstadt, http://www.math-learning.com/files/PP_Bruder2008_deutsch.pdf

BRUDER, REGINA; INGELMANN, MARIA (2007). Durch CAS-Einsatz ab Klasse 7 den Umgang mit mathematischen Darstellungen fördern, TU Darmstadt, http://www.mathematik.tu-darmstadt.de/fbereiche/didaktik/research/Publicationen/GDM-beitrag2007Ing_Bu.pdf

BRUDER, REGINA (2006). Meaningful use of CAS in school -- a project report. (Sinnvoller Einsatz von CAS in der Schule - ein Projektbericht.), http://www.math-learning.com/files/TI_Abschlussbericht.pdf

HUSSMANN, STEPHAN; LAAKMANN, HEINZ (2008): "MuT – Mathematikunterricht und Technologieeinsatz". An empiric analysis of the effects of the use of computers focussing the flexible application of representation and the development of imaginations in the field of functional thinking, Technical University Dortmund, *not published yet*

PESCHEK, WERNER; SCHNEIDER, EDITH (2007). TI-Nspire im Mathematikunterricht – Kommentar zum Pilotprojekt aus fachdidaktischer Sicht. Klagenfurt, 94 S.

SCHMIDT, KARSTEN (2002). The Use of CAS in the Thuringian School System: Present and Future, In: Borovcnik, M. und Kautschitsch, H. (Hrsg.), Technology in Mathematics Teaching, Wien

SCHNEIDER, EDITH (2002) Computer algebra systems in general mathematics education. Didactical orientation - practical experiments. (Computeralgebrasysteme in einem allgemeinbildenden Mathematikunterricht. Didaktische Orientierungen - Praktische Erfahrungen.), Profil Verl., München. 300 p.

WEIGAND, HANS-GEORG (2006). Using scientific calculators in Year 10. (Der Einsatz eines Taschencomputers in der 10. Jahrgangsstufe. Evaluation eines einjährigen Schulversuchs.) J. Math.-Didakt. 27, No. 2, 89-11

WEIGAND, HANS-GEORG; WELLER, HUBERT (2001). Changes of working styles in a computer algebra environment. The case of functions.

3) Summary and Analysis of different Researches (Zusammenfassung und Analyse verschiedener Studien)

3.1) Research Projects (Wissenschaftlich fundierte Studien)

Barzel 2006, summary

Reference of the publication

BARZEL, BÄRBEL (2006), MUKI – Mathematikunterricht zwischen Konstruktion und Instruktion, Dissertation, Universität Duisburg-Essen, <http://duepublico.uni-duisburg-essen.de/>

Keywords

Calculator, Computer Algebra System, polynomial function, learning workshop

Abstract

This dissertation shows that the three terms content, use of calculators and autonomous learning do not necessarily have to be separated from each other as additional burdens, but linked to each other. The “learning workshop” is a way of learning criteria to investigate functions and of applying the knowledge confidently.

Type of publication

Dissertation describing an experiment and its results

Design of the study

50 grade 11 courses and 45 teachers involved

Instruments: 1) concerning only one class (Pilot Project): data collection through video recording, copies of students' notes, interviews of five students and their teacher, comparison test in the experimental class and three other grade 11 courses; 2) concerning 50 courses: students' survey and teachers' survey, comparative test at the end of the academic year

Theoretical framework: design research

Mathematics fields

Functions (polynomial functions), calculus

Technological Environment

Mainly Calculators TI-92 and Voyage 200 (a few classes in the quantitative study used CAS on PC - Derive or Maple)

Authors and teachers involved

The author used to be a teacher and is now lecturer in Freiburg. She is involved in CAS- or GC-projects at the moment.

Time of experimentation

The experimentation took place from 2002 until summer 2004 (including qualitative and quantitative research)

Students

Grade: 50 courses of 11th grade, about 450 students took part at the final comparison test and about 580 answered to a questionnaire

Documentation of teacher

surveys

Barzel 2006, Resümee

Quellenangabe der Veröffentlichung

BARZEL, BÄRBEL (2006), MUKI – Mathematikunterricht zwischen Konstruktion und Instruktion, Dissertation, Universität Duisburg-Essen, <http://duepublico.uni-duisburg-essen.de/>

Stichwörter

Taschenrechner, Computer Algebra System, Ganzrationale Funktionen, Lernwerkstatt

Kurzfassung

In dieser Dissertation wird gezeigt, dass die drei Zielbereiche Inhalt, Rechneinsatz und selbstständiges Lernen keinesfalls getrennt als additive Herausforderungen sondern als Verbindung zu sehen sind. Die Lernwerkstatt ist ein Weg Kriterien zur Funktionsuntersuchung und deren souveräne Anwendung selbstständig zu lernen.

Art der Veröffentlichung

Dissertation, die ein Experiment und dessen Ergebnisse beschreibt

Studienaufbau

50 Kurse der 11. Klasse und 45 beteiligte Lehrer

Instrumente: 1) hinsichtlich einer 11. Klasse (Modellversuch): Datensammlung durch Videoaufnahmen, Kopien von Schülerheften, Interviews mit 5 Schülern sowie deren Lehrer, Vergleichsklausur von dem Experimentalkurs und drei Parallelkursen; 2) hinsichtlich der 50 Kurse: Lehrer- und Schülerfragebögen, Abschlusstest

Theoretischer Hintergrund: Design Research

Mathematische Bereiche

Funktionen (Potenzfunktionen), Algebra

Eingesetzte Technologie

Hauptsächlich Taschenrechner TI-92 und Voyage 200 (in einigen Klassen wurde für die quantitative Datensammlung auch Derive und Maple eingesetzt)

Beteiligte Autoren und Lehrer

Die Autorin war Lehrerin und ist nun Dozentin an der Pädagogischen Hochschule Freiburg.

Experimentierzeit

Die Studie verläuft über einen Zeitraum von zwei Jahren (2002- 2004), qualitative und quantitative Datenerhebung inbegriffen.

Schüler

50 Kurse der 11. Klasse, ungefähr 450 Schüler(innen) nahmen an dem letzten Vergleichstest teil und ungefähr 580 beantworteten den Fragebogen

Dokumentation der Lehrer(innen)

Lehrerfragebogen

Barzel 2006, analysis

General objectives of the publication and public concern

Main intention of the project is it to show on an example that the three aspects content, use of calculators and autonomous learning are not to be separated, but that all three present a realistic unit. Pupils should experience that mathematics is not a convenience product but something nascent and a process.

Aim of the “learning workshop” was it that the learners become acquainted to the criteria of analyzing functions and applying the criteria confidently. Important in that context was that the pupils get encouraged to different cognitive activities by the various tasks. CAS had to be available all the time.

Main results

From the mathematical point of view

There was not more expenditure of time necessary comparing to the traditional way of teaching. Following the results of the comparison post-test you can see that pupils learning in the experimental environment can succeed in the same way or better than pupils who have learned the stuff in a classical way.

From the students’ point of view

The students’ cognitive (such as interpreting, structuring and reflecting in the sense of comparing, reorganising and linking of new knowledge) and meta-cognitive activities were encouraged. The students show good recognition of graphs and terms. They can fluently switch between different representations like term and graph. The low achievers give the highest estimation of the whole classroom arrangement.

From the teachers’ point of view

The role of the teacher in this new concept is to supervise and to accompany the learners’ processes. He has to act as moderator in the classroom.

From the technological point of view

The use of CAS is for both teachers and learners an important and indispensable tool in the “learning workshop”. CAS is not only used for visualisation and calculation but also for verifying and falsifying individual ideas and generating examples. This is what pupils point out themselves and can be observed in group work interaction.

From the point of view of classroom organisation

The most important basic principle to encourage cognitive activities is free work in groups of pupils, in the sense of without permanent observation and control of the teacher.

The author’s results and conclusion

If teachers and pupils are used to such an open classroom organisation, so that the roles and duties are clear, such an open arrangement gives the pupils the opportunity to learn self dependently with an integration of CAS which can be seen as a successful way of teaching and learning new areas of mathematics.

Bruder 2008, summary

Reference of the publication

BRUDER, REGINA (2008), TIM – Ein zweijähriger Modellversuch zum Einsatz von Taschencomputern ab Klasse 7, Technische Universität Darmstadt, http://www.math-learning.com/files/PP_Bruder2008_deutsch.pdf

Keywords

Pilot project, Computer Algebra, Calculators

Abstract

This article gives an overview of the concept and some event of a pilot project at German High Schools (Gymnasium). The results of the research recommend the use of handheld calculators beginning from the 7th grade (12-/ 13-years old students) and show the impact calculators have in class. The use of such modern technology in the classroom does, for instance, improve the students' competence of communication.

Type of publication

Article describing the project and its results, giving an overview and referring to another, more detailed research called CALiMERO which is still in progress

Design of the study

TI-84 Plus introduced in grade 7, TI-Voyage in grade 9

Instruments: test at the beginning and the end of every academic year, three students surveys and two teachers surveys, record of the lessons in the first year (from teachers), record concerning the lessons in the second year (from students)

Mathematics fields

Algebra, functions, arithmetic

Technological Environment

Calculator TI-Voyage 200 and TI-Nspire CAS (grade 9 and 10), Calculator TI-84 Plus (grade 7 and 8)

Authors and teachers involved

The 13 teachers involved had no or very little experience working with calculators in the classroom.

Time of experimentation

The project started in 2005 and continued until 2007.

Students

Six grade 7 classes (12-/ 13-years old) and seven grade 9 classes (14-/ 15-years old) at eight different German High Schools (Gymnasium), little or no experience with such calculators

Documentation of teacher

met every 3 months, worked on didactical concepts together, communicated through a learning platform (www.proLehre.de) where all tasks, teaching plans, suggested solutions and technical hints are available for all teachers participated

Bruder 2008, Resümee

Quellenangabe der Veröffentlichung

BRUDER, REGINA (2008), TIM – Ein zweijähriger Modellversuch zum Einsatz von Taschencomputern ab Klasse 7, Technische Universität Darmstadt, http://www.math-learning.com/files/PP_Bruder2008_deutsch.pdf

Stichwörter

Modellversuch, Computer Algebra System, Taschenrechner

Kurzfassung

Dieser Artikel gibt einen Überblick über das Konzept und einige Ereignisse während des Modellversuchs an acht verschiedenen Gymnasien in Rheinland-Pfalz. Die Ergebnisse legen einen Einsatz von Taschencomputern bereits ab der 7. Jahrgangsstufe (13-/14-Jährige) nahe und zeigen den Einfluss, den der Rechnereinsatz auf beispielsweise die Kommunikationskompetenz der Schüler(innen) hat.

Art der Veröffentlichung

Artikel, der das Projekt und dessen Ergebnisse darstellt, einen Überblick gibt und auf ein größer angelegtes Projekt CALIMERO (noch nicht beendet) verweist

Studienaufbau

TI-84 Plus eingeführt in Klasse 7, TI-Voyage 200 in Klasse 9

Instrumente: Schülerleistungstest zu Beginn und am Ende eines jeden Schuljahres, drei Schüler- und zwei Lehrerumfragen, Unterrichtsprotokolle im ersten Projektjahr von den Lehrern, teilstandardisierte Unterrichtsprotokolle im zweiten Projektjahr von den Schülern

Mathematische Bereiche

Algebra, Funktionen, Arithmetik

Eingesetzte Technologie

Taschenrechner TI-Voyage 200 und TI-Nspire CAS (Klasse 9 und 10), Taschenrechner TI-84 Plus (Klasse 7 und 8)

Beteiligte Autoren und Lehrer

Die 13 beteiligten Lehrer(innen) hatten zu Beginn des Projektes keine bis wenig Erfahrung mit dem Rechnereinsatz im Unterricht.

Experimentierzeit

Der Modellversuch begann 2005 und wurde 2007 beendet.

Schüler

Sechs 7. Klassen (13-/ 14-Jährige) und sieben 9. Klassen an acht verschiedenen Gymnasien, wenig oder keine Erfahrung mit Taschencomputern

Dokumentation der Lehrer(innen)

Trafen sich vierteljährlich, erarbeiteten Unterrichtskonzepte, verständigten sich über eine Lernplattform (www.proLehre.de), wo alle Beteiligten Aufgabenstellungen, Unterrichtsentwürfe, Lösungsvorschläge und technische Hinweise austauschen konnten

Bruder 2008, analysis

General objectives of the publication and public concern

Questions concerning the acceptance of calculators from teachers and students, the potential of developing mathematical competence, the conditions for successful learning, the impact on attitudes towards mathematics, the perception of lessons, the students' development of competences

Main results

From the point of view of the research

Expectations which were phrased beforehand: enhancement of the acceptance in two years time, the potential in respect of the development of competences (communicating and mathematical modelling) should take effect, certain basic skills should be remained, focus on the students' development of competences

From the mathematical point of view

Continuous inserted mental arithmetic help to keep basic mathematical skills present.

From the students' point of view

The improvement of the output is much higher than in classes not taught with a handheld calculator. Generally, girls and low achievers have the highest improvement. All students of grade 7 have a positive attitude towards technology in maths. In form 9 and 10, the attitude is less positive. Therefore, the earlier a calculator is introduced, the better students can adopt the new way of teaching.

From the teachers' point of view

The methodology changed a lot for instance the class arrangements or the role of the teacher. Students talked about 60% of the lesson.

From the technological point of view

The calculators were used in half of the each lesson. The function was pretty different. Some teachers preferred single- or group work, others only used it for demonstration.

From the point of view of classroom organisation

N/A

The author's results and conclusion

Special output increase, but still, important mathematical issues have to be repeated various times to be recallable; continuous training without the calculator keeps solid basic skills, above average improvement in terms of competences of modelling and communicating (grade 9 and 10), as well as in problem solving and communicating (grade 7 and 8)

Schneider 2002, summary

Reference of the publication

SCHNEIDER, EDITH (2002) Computeralgebrasysteme in einem allgemeinbildenden Mathematikunterricht. Didaktische Orientierungen - Praktische Erfahrungen. Profil Verl., München. 300 p.

Keywords

Computer Algebra, educational research, didactic, case studies

Abstract

The book consists of three parts. The first one gives a first didactical orientation for concepts and the evaluation of suggestion of lessons. In the second part the project which took three years is presented. The third part finishes with the analysis of didactical aspects concerning the use of CAS.

Type of publication

Book focusing on the project and its results

Design of the study

approximately 40 grade 11 students (16-/ 17-years old) at two commercial academies, two teachers

Instruments: design of two sequences of lessons and the designed material

Theoretical framework: basic elements of the method of action research (Altrichter/Posch 1990, Elliot 1985)

Mathematics fields

Trigonometry, Functions (exponential functions, logarithm), Calculus (differentiation, integration), Financial Mathematics

Technological Environment

Calculator TI-92

Authors and teachers involved

Schneider is involved with didactical issues concerning the use of computer in maths lessons since many years. The two teachers wanted the project to be extended from one to three years in order to let the students accomplish their A-levels.

Time of experimentation

The project started in summer 1997 and finished in summer 2000.

Students

Approximately 40 grade 11 students (16-/ 17-years old) at two different commercial academies

Documentation of teacher

Two teachers worked in closed cooperation and designed material for the use of CAS in maths lessons

Schneider 2002, Resümee

Quellenangabe der Veröffentlichung

SCHNEIDER, EDITH (2002) Computeralgebrasysteme in einem allgemeinbildenden Mathematikunterricht. Didaktische Orientierungen - Praktische Erfahrungen. Profil Verl., München. 300 p.

Stichwörter

Computeralgebra, Bildungsforschung, Didaktik, Modellversuch

Kurzfassung

Das Buch besteht aus drei Teilen, wobei im ersten didaktische Orientierungen für die Konzeption und die Bewertung von Unterrichtsvorschlägen gegeben werden. Im zweiten Teil wird das mehrjährige Unterrichtsprojekt ausführlich dargestellt. Der dritte Teil schließt mit der Analyse didaktischer Aspekte im Hinblick auf die Verwendung von CAS ab.

Art der Veröffentlichung

Buch, das sehr ausführlich auf das Projekt und dessen Ergebnisse eingeht

Studienaufbau

ca. 40 Schülerinnen und Schüler der Jahrgangsstufe 11 (16-/ 17-Jährige) an zwei verschiedenen Handelsakademien, zwei Lehrerinnen

Instrumente: zwei Unterrichtssequenzen und die dazu ausgearbeiteten Materialien

Theoretischer Hintergrund: Grundelemente der Methode der Aktionsforschung (Altrichter/Posch 1990, Elliot 1985)

Mathematische Bereiche

Exponential- und Logarithmusfunktionen, Differenzial- und Integralrechnung, Trigonometrie, Finanzmathematik

Eingesetzte Technologie

Taschenrechner TI-92

Beteiligte Autoren und Lehrer

Schneider beschäftigt sich seit mehreren Jahren mit didaktischen Fragen des Computereinsatzes im Mathematikunterricht. Die zwei Lehrerinnen haben das ursprünglich auf ein Jahr konzipierte Projekt auf eigenen Wunsch zwei Jahre verlängert (bis zum Abitur).

Experimentierzeit

Das Projekt begann mit dem Schuljahr 1997/1998 und endete mit dem Schuljahr 1999/2000.

Schüler

Ca. 40 Schülerinnen und Schüler der Jahrgangsstufe 11 (16-/ 17-Jährige) an zwei verschiedenen Handelsakademien

Dokumentation der Lehrer(innen)

Zwei Lehrerinnen arbeiten in sehr enger Kooperation und entwerfen Unterrichtsmaterialien zum Einsatz von CAS im Mathematikunterricht

Schneider 2002, analysis

General objectives of the publication and public concern

Two main aims: 1) conceptual concept of a course of instruction for an integrated, CAS-supported maths class; designing appropriate teaching materials and testing them; 2) collection of experiences with a long-term cooperation between science and teaching practice during a radical and widespread change of maths lessons

Object of research: changes of the teachers' behaviour in respect of aims, contents, methods, class arrangements; classes intended, designed and planned by teachers; realisation of the classes

The project focused on the teachers' behaviour, individual's main focus, methodological proceeding and used class arrangements.

Main results

From the point of view of the research

The project was conceived for one academic year and was then expanded to three years. There are now new concepts as well as books and workbooks for students.

From the mathematical point of view

N/A

From the students' point of view

The used technology attracted the students' attention. Hence, there were situations when key combinations seemed much more interesting than the actual mathematical background.

From the teachers' point of view

The teachers had an immense workload during the designing and planning of the teaching concepts. Even though, the workload was huge, the teachers could identify themselves with their composition.

From the technological point of view

N/A

From the institutional point of view

In comparison to classes taught the traditional way the classes using technology in maths lessons had a clearly different basis, namely an emphasis on the development of basic knowledge and intuitive-demonstrative basic conception, an emphasis on interpretation and the design of mathematical conceptions, of tasks, of the different forms of representations (including the connection between them) as well as class arrangement and teaching methods which support freelance work, independence, communication and cooperation.

The author's results and conclusion

Generally, the traditional way of teaching shows a respectable resistance against the didactical development. Nevertheless, the availability of technology leveraged didactical ideas that were already known and lead to an elementary reorientation in maths classes.

Weigand 2006, summary

Reference of the publication

WEIGAND, HANS-GEORG (2006), Using scientific calculators in Year 10. (Der Einsatz eines Taschencomputers in der 10. Jahrgangsstufe. Evaluation eines einjährigen Schulversuchs.), J. Math.-Didakt. 27, No. 2, 89-11

Keywords

Calculators, examinations, way of posing a problem, grade 10, educational research

Abstract

This article describes a one year project to test the use of scientific calculator in 10th grade (15-/ 16-years old) of three grammar schools in Bavaria (Germany). The evaluation was intended give answers to several questions: if basic mathematical skills changed; how the question posed in examinations changed if students were allowed to use a scientific calculator; how the students evaluated the use of the new tool; and how teaching styles and methods changed in the mathematics lessons. This article presents the results of this project.

Type of publication

Article giving an overview of the development of scientific calculators; describing an experiment and its results

Design of the study

six grade 10 classes (15-/ 16-years old) at three Bavarian grammar schools (total: 137 students), four classes not taught with a handheld calculator (total: 121 students)

Instruments: pre- and post test (both were written in all 14 classes, only with pencil and paper), a survey consisting of ranking and open questions, record of each lesson concerning the content, the time used a scientific calculator and the way it was used

Mathematics fields

Functions (power functions, exponential function, logarithm), geometry (trigonometry, circle measuring, sphere, cone, cylinder), algebra (sequence and series)

Technological Environment

Calculator TI Voyage 200

Authors and teachers involved

The teachers had experience working with CAS already and established the work group "CAS" in 2000/2001 so they could exchange information more easily.

Time of experimentation

The project was carried out in the academic year 2003/2004.

Students

Six grade 10 classes (15-/ 16-years old) at three Bavarian grammar schools (total: 137 students), four classes not taught with a handheld calculator (total: 121 students)

Documentation of teacher

Records of each lesson and meetings in the "CAS work group"

Weigand 2006, Resümee

Quellenangabe der Veröffentlichung

WEIGAND, HANS-GEORG (2006), Using scientific calculators in Year 10. (Der Einsatz eines Taschencomputers in der 10. Jahrgangsstufe. Evaluation eines einjährigen Schulversuchs.), J. Math.-Didakt. 27, No. 2, 89-11

Stichwörter

Taschenrechner, Prüfung, Problemstellung, Jahrgangsstufe 10, Bildungsforschung

Kurzfassung

Dieser Artikel beschreibt einen einjährigen Unterrichtsversuch zum CAS-Einsatz in der 10. Jahrgangsstufe (15-/ 16-Jährige) an drei bayerischen Gymnasien. Der Artikel stellt die Ergebnisse der folgenden Fragen dar: Welche Veränderungen lassen sich hinsichtlich zentraler mathematischer Fähigkeiten nach einem Jahr feststellen; Wie ändern sich Prüfungsaufgaben aufgrund des CAS-Einsatzes, Wie schätzen Schüler(innen) den CAS-Einsatz ein und Wie ändert sich die Unterrichtsmethodik durch den CAS-Einsatz ändert.

Art der Veröffentlichung

Der Artikel beschreibt das Projekt und stellt die Ergebnisse übersichtlich dar

Studienaufbau

sechs Klassen der 10. Klasse (15-/ 16-Jährige) an 3 bayerischen Gymnasien (insgesamt 137 Schüler(innen)), 4 Kontrollklassen (insgesamt 121 Schüler(innen))

Instrumente: Vor- und Nachtest (in allen Klassen durchgeführt, TC war nicht erlaubt), Fragebogen mit 5-stufiger Rating-Skala sowie Fragen mit offenen verbalen Antworten, Stundenprotokolle zum Thema der Stunde, der Unterrichtszeit mit dem CAS-Einsatz und zur Art des CAS-Einsatzes

Mathematische Bereiche

Funktionen (Potenzfunktionen, Exponential- und Logarithmusfunktionen), Algebra (Folgen und Reihen), Arithmetik (Rechnen mit Potenzen und Potenzgesetzen), Geometrie (Kreismessung, Volumen und Oberfläche von Zylinder, Kegel und Kugel, Trigonometrie)

Eingesetzte Technologie

Taschenrechner TI Voyage 200

Beteiligte Autoren und Lehrer

Der Autor war Lehrer und ist heute Dozent. Die beteiligten Lehrer hatten bereits Erfahrung mit dem Einsatz von CAS. Sie haben im Jahr 2000/2001 den Arbeitskreis „CAS“ gegründet

Experimentierzeit

Das Projekt fand im Schuljahr 2003/2004 statt.

Schüler

sechs Klassen der Jahrgangsstufe 10 an drei bayerischen Gymnasien (insgesamt 137 Schülerinnen und Schüler), vier Kontrollklassen (insgesamt 121 Schülerinnen und Schüler)

Dokumentation der Lehrer(innen)

Unterrichtsprotokolle und die Treffen des Arbeitskreises "Computeralgebrasysteme"

Weigand 2006, analysis

General objectives of the publication and public concern

Research questions: change of basic mathematical skills (algebraic transformations, solving equations, working with tables and formulas); change of questions posed in examinations; evaluation of the new tool from the students' point of view; change of teaching styles and methods in the mathematics lessons

Aim of the project: to show possibilities and chances as well as problems and difficulties of using CAS, to give planning advices for a longitudinal project

Main results

From the point of view of the research

The expected "effect of scissors", namely that high achievers improve more and low achievers worsen, did not occur. Quite the contrary, the biggest output increase could be noticed in the lower and middle achiever groups.

From the mathematical point of view

N/A

From the students' point of view

Generally, the maths classes were more interesting and more diversified. The use of scientific calculators enabled the students to get to know mathematics from a different point of view. They felt an easement because of the use of CAS in maths lessons.

They did not have the impressions neither to have learned more nor to be involved more often. A polarisation in two groups was noticed from the questionnaires: 1) enjoys working with CAS, used it outside school, did not have any difficulties when using it, wants to use it again; 2) did not enjoy it that much, did not spend any additional time with CAS, had difficulties using it

Positive: drawing graphs, controlling calculations, writing a table; *negative:* control elements of CAS

From the teachers' point of view

Positive: opportunity to show functions in different representations (graphs, tables) easily, opportunity to control calculations, *negative:* display not useful for geometry, much more expenditure of time for preparation and realisation of the lesson

From the technological point of view

Calculator was used for/as: new strategies of solutions, expansion of strategies of solutions, heuristic tool, check instrument,

From the point of view of classroom organisation

CAS is easy to integrate and to be used in examinations. Change of working styles: single, pair and group work were appeared more often (scientific calculators are catalysts for new teaching methods)

The author's results and conclusion

N/A

3.2) Research projects that are still in progress (unbeendete, wissenschaftlich fundierte Studien)

Bichler, Weigand, 2008, summary

Reference of the publication

BICHLER, E.; WEIGAND, H.-G., Evaluation des Modellversuchs "Medienintegration im Mathematikunterricht - M³" - im Schuljahr 2006/07, TI-Nachrichten - Sonderausgabe Forschung, 2008, 14-15

Keywords

Pilot project, integration of media

Abstract

The pilot project M3 (Integration of media in maths classes) was initiated in the academic year of 2003/2004 and will finish in 2011. The academic year of 2006/2007 (grade 11, 16-/17- years old) was evaluated lastly.

Type of publication

Article describing an on-going experiment and results of the first year

Design of the study

412 students in the experiment class, 320 students in control classes at 11 Bavarian grammar schools

Instruments: pre- and post test with using a calculator, test in which the experiment classes had to describe their way of finding results, monthly survey for teachers and questionnaire at the end of each academic year, online questionnaire for students about experiences and attitudes towards pocket computers, professional adjustment of the test written in the experiment classes

Mathematics fields

N/A

Technological Environment

Calculator Voyage 200, Calculator TI- Nspire CAS

Authors and teachers involved

The teachers involved are not trained in using a CAS. They do not pursuit any special collegial concept for teaching.

Time of experimentation

The project started in summer 2003 and will finish in summer 2011.

Students

412 students in the experiment class, 320 students in control classes at 11 Bavarian grammar schools

Documentation of teacher

Surveys and questionnaires

Bichler, Weigand 2008, Resümee

Quellenangabe der Veröffentlichung

BICHLER, E.; WEIGAND, H.-G., Evaluation des Modellversuchs "Medienintegration im Mathematikunterricht - M3" - im Schuljahr 2006/07, TI-Nachrichten - Sonderausgabe Forschung, 2008, 14-15

Stichwörter

Modellversuch, Medienintegration

Kurzfassung

Der Modellversuch M3 – Medienintegration im Mathematikunterricht wurde im Schuljahr 2003/2004 gestartet und wird im Jahr 2011 abgeschlossen. Im Schuljahr 2006/2007 wurde der Modellversuch erstmals in der 11. Klasse (16-/ 17-Jährige) evaluiert.

Art der Veröffentlichung

Artikel, der ein noch laufendes Projekt und Ergebnisse des ersten Versuchsjahres präsentiert

Studienaufbau

11 bayerische Gymnasien mit 412 Schüler(innen) in den Modellklassen und 320 Schüler(innen) in den Kontrollklassen

Instrumente: Vor- und Nachtest ohne Verwendung des TC, zusätzlicher Test in den Modellklassen über die Arbeitsweise mit dem TC, monatliches Ausfüllen eines Online-Fragebogens und Einschätzungsfragebogen am Ende des Schuljahres seitens der Lehrkräfte, Online-Wertungsfragebogen über Erfahrungen und Einstellungen zum TC am Ende des Schuljahres seitens der Schüler(innen), Einschätzung der geschriebenen Klassenarbeiten durch ein Expertenurteil

Mathematische Bereiche

Keine Angaben

Eingesetzte Technologie

Taschenrechner Voyage 200, Taschenrechner TI-Nspire CAS

Beteiligte Autoren und Lehrer

Die beteiligten Lehrkräfte waren nicht für das Unterrichten mit CAS geschult. Sie verfolgen kein spezielles gemeinsames Konzept beim Unterrichten.

Experimentierzeit

Das Projekt begann im Sommer 2003 und wird im Sommer 2011 enden.

Schüler

11 bayerische Gymnasien mit 412 Schüler(innen) in den Modellklassen und 320 Schüler(innen) in den Kontrollklassen

Dokumentation der Lehrer(innen)

Monatliche Fragebögen und am Jahresende ein Einschätzungsfragebogen

Bichler, Weigand 2008, analysis

General objectives of the publication and public concern

Analysis of differences between the experiment classes and the control classes concerning basic mathematical skills, different impacts on “good” and “bad” students, changing the tasks, how skilled the students are at the end of the school year, using the handheld computer during tests, attitudes towards their new tool

Main results

From the point of view of the research

These are results from only one year of experiment. The whole project will be accomplished in 2011.

From the mathematical point of view

N/A

From the students' point of view

It took more than six months until the students knew how to use the calculator properly. At the end of grade 11 some students were overstrained in terms of technical issues as well as the appropriate use. Only at the end of the year, students used the calculator at the beginning of each task (graphic as overview) and at the end to check the solution.

From the teachers' point of view

The calculator is a helpful tool in maths lessons which entails changes in the way of teaching (class arrangements, methodology). The main use was not graphical and numeral method but symbolic tool and plotter of functions.

On one hand, the content of the traditional teaching has not changed (60% of the teachers). On the other hand, the methodology has changed (70%). Most teachers agree in the improvement the students had in understanding contents better.

From the technological point of view

The calculator always has to be available. Most teachers prefer working with the handheld calculator.

From the point of view of classroom organisation

N/A

The author's results and conclusion

N/A

Bruder, Ingelmann 2007, summary

Reference of the publication

BRUDER, REGINA; INGELMANN, MARIA (2007). Durch CAS-Einsatz ab Klasse 7 den Umgang mit mathematischen Darstellungen fördern, TU Darmstadt, http://www.mathematik.tu-darmstadt.de/fbereiche/didaktik/research/Publikationen/GDM-beitrag2007Ing_Bu.pdf

Keywords

Educational research, computer algebra, teaching-learning processes, experience report, students' attitudes

Abstract

This article gives an overview of the project CALiMERO (Computer-Algebra in Maths lessons – Discover, Calculate, Organize) which is taking place in Lower Saxony (Germany). It presents first results of the project which will only finish in 2010. CALiMERO started in 2005. The teachers tried to establish a new curriculum and new concepts of teaching mathematics. This concept was then used and tested by 50 schools in 2006/2007.

Type of publication

Article describing the project and first results

Design of the study

29 grade 7 classes at six different grammar schools in Lower Saxony; 5 control classes (in total: approximately 1000 students)

Instruments: Analysis of the designed material, Analysis of students' work, standardised record of each lesson in the first year (filled in by teacher), standardised questionnaire for each lesson (filled in by student), teachers' survey every academic year, pre- and post-test for students of the classes taught with CAS and of classes taught in the traditional way, students' survey every academic year

Mathematics fields

N/A

Technological Environment

Calculator TI Voyage 200

Authors and teachers involved

Bruder is one of the researchers who focuses on longitudinal studies project that take a long time. She accompanied the project in terms of the development and the discussion of the new concepts and the evaluation of implementation of the new concept in grammar schools.

Time of experimentation

The project is taking place from summer 2005 until summer 2010.

Students

29 grade 7 classes at six different grammar schools, five control classes

Documentation of teacher

Surveys, cooperation between the teachers, meetings every 3 months

Bruder, Ingelmann 2007, Resümee

Quellenangabe der Veröffentlichung

BRUDER, REGINA; INGELMANN, MARIA (2007). Durch CAS-Einsatz ab Klasse 7 den Umgang mit mathematischen Darstellungen fördern, TU Darmstadt, http://www.mathematik.tu-darmstadt.de/fbereiche/didaktik/research/Publicationen/GDM-beitrag2007Ing_Bu.pdf

Stichwörter

Bildungsforschung, Computeralgebra, Lehr-Lern-Vorgänge, Erfahrungsbericht, Einstellungen von Schülerinnen und Schülern

Kurzfassung

Dieser Artikel gibt einen Überblick von dem Modellversuch CALIMERO (Computer-Algebra im Mathematikunterricht – Entdecken, Rechnen, Organisieren), der in Niedersachsen (Deutschland) seit 2005 durchgeführt wird. Alle beteiligten Lehrpersonen haben versucht ein Curriculum und Gestaltungskonzepte für den Mathematikunterricht ab der Jahrgangsstufe 7 zu entwickeln. Diese Konzepte wurden im Schuljahr 2006/2007 bereits von ca. 50 Schulen genutzt und getestet.

Art der Veröffentlichung

Artikel, der das Projekt und erste Ergebnisse beschreibt

Studienaufbau

29 Klassen der Jahrgangsstufe 7 an sechs verschiedenen Gymnasien in Niedersachsen, 5 Vergleichsklassen (insgesamt ca. 1000 Schüler(innen))

Instrumente: Analyse des entwickelten Materials und von Arbeitsprodukten der Schüler, standardisierte Unterrichtsprotokolle im ersten Projektjahr (vom Lehrer ausgefüllt), standardisierte Fragebögen zu jeder Stunde im zweiten Projektjahr (von einem Schüler ausgefüllt), Lehrer- und Schülerbefragung, Vor- und Nachtest

Mathematische Bereiche

Keine Angaben

Eingesetzte Technologie

Taschenrechner TI Voyage 200

Beteiligte Autoren und Lehrer

Bruder ist eine der deutschen Forscherinnen, die Langzeitstudien zum Rechnereinsatz durchführt. Sie begleitete das Projekt bezüglich der Entwicklung und Diskussion des Unterrichtskonzeptes und der Evaluation der Umsetzung des Konzeptes an den Gymnasien.

Experimentierzeit

Das Projekt wird seit Sommer 2005 durchgeführt und endet im Sommer 2010.

Schüler

29 Klassen der Jahrgangsstufe 7, fünf Vergleichsklassen

Dokumentation der Lehrer(innen)

Befragungen, enge Kooperation zwischen den Lehrern, vierteljährliche Treffen

Bruder, Ingelmann 2007, analysis

General objectives of the publication and public concern

Main aim: designing a didactical and methodological concept to integrate calculators from grade 7 classes onwards; analysis: the potential that CAS has in respect of the development of mathematical competences

Main results

From the point of view of the research

The calculator is accepted from teachers as well as students. All participants recognized a positive change of teaching styles.

From the mathematical point of view

N/A

From the students' point of view

Low achievers have a huge output increase. In general, all students have improved their achievements. The general impression and the arrangements of the lessons were judged positively. The time for autonomous discovering of mathematical correlations and trying to find different ways for solutions was increased. There was the opportunity to discuss and present results more often. The support of competences by the teacher decrease during the experimental time.

From the teachers' point of view

Positive: students can try and find a solution themselves, teachers benefit from the self-designed resources, teachers have got suggestions for their lessons and changed their teaching style in favour of the variety of methods, working with the calculator was mainly in groups

Negative: higher time expenditure than expected, problems using the calculator

From the technological point of view

The calculator is established as natural tool in maths lessons.

From the point of view of classroom organisation

CAS conveys communication about mathematical contents.

The author's results and conclusion

Most problems are due to the adjustment to and adaption of new concepts (from teachers and students). The biggest benefit that can be given by CALiMERO until 2010 will be an improvement in terms of time management and coping with heterogeneity.

All detailed results can be found on www.proLehre.de under the heading "Computereinsatz im Mathematikunterricht – Modellversuche"

Hußmann, Laakmann 2008, summary

Reference of the publication

HUSSMANN, STEPHAN; LAAKMANN, HEINZ (2008): "MuT – Mathematikunterricht und Technologieeinsatz". An empiric analysis of the effects of the use of computers focussing the flexible application of representation and the development of imaginations in the field of functional thinking, Technical University Dortmund, *not published yet*

Keywords

TI-Nspire

Abstract

Both, the article and the dissertation, analyze the effects of the use of computers, by focussing the flexible application in several forms of representation (graphical, numerical, symbolic and verbal) and the relation between the development of functional thinking and linear functions. To analyze this, three classes (sixth forms) of a German grammar school were researched in the mathematical field of linear functions and the use of TI-Nspire. As pilot studies show, the choice of forms of representation depend on (1) the experience students make in their lesson-culture, (2) the competence to use several forms of representation and (3) the understanding of each subject area. Based on the use of digital media there will be the instrumental competence an important one as well.

Type of publication

Dissertation and master degree describing the project and its results.

Design of the study

TI-Nspire introduced in grade 7 and 8

Instruments: Lab-study, video recorded lessons, products of learning processes from students, guided interviews with students and teachers, reports and observation forms of exemplary mathematic lessons

Mathematics fields

Functions (linear)

Technological Environment

Calculator TI-Nspire

Authors and teachers involved

The five teachers involved had experience working with calculators in the classroom.

Time of experimentation

The project starts in school year 2006 and end in 2008.

Students

3 grade 7 classes and 2 grade 8 classes at two different German grammar schools, experience with calculators or digital media in mathematic lessons exist.

Documentation of teacher

Observation forms of mathematic lessons

Hußmann, Laakmann 2008, Resümee

Quellenangabe der Veröffentlichung

HUSSMANN, STEPHAN, LAAKMANN, HEINZ (2008): MuT – Mathematikunterricht und Technologieeinsatz. Eine empirische Untersuchung zu den Auswirkungen des Rechnereinsatzes auf die flexible Verwendung von Darstellungen und Vorstellungsentwicklung im Themenfeld des funktionalen Denkens, Technische Universität Dortmund, *noch nicht veröffentlicht*

Stichwörter

TI-Nspire

Kurzfassung

Die beiden oben genannten Arbeiten untersuchen die Auswirkungen des Rechnereinsatzes auf die flexible Nutzung von unterschiedlichen Darstellungsformen (graphisch, numerisch, symbolisch und verbal) und die Entwicklung des funktionalen Denkens zu linearen Funktionen. Dazu wurde der Einsatz des TI-Nspire in drei Klassen der gymnasialen Sekundarstufe I im Themenfeld der linearen Funktionen untersucht. Vorstudien gaben Hinweise darauf, dass die Wahl der Darstellungsform abhängig ist von der erlebten Unterrichtskultur, der Kompetenz, die jeweiligen Darstellungen zu nutzen, und dem inhaltlichen Verständnis des jeweiligen Themenfeldes. Bezogen auf den Einsatz von digitalen Medien kommt die Werkzeugkompetenz als wichtiger Einflussfaktor mit hinzu.

Art der Veröffentlichung

Dissertation und Staatsexamensarbeit, die das Projekt und dessen Ergebnisse vorstellt;.,

Studienaufbau

TI-Nspire eingeführt im 7. und 8. Jahrgang

Instrumente: Laborstudie, videografierte Unterrichtsstunden, Schülereigenproduktionen und Leitfaden gestützte Schüler/Schülerinnen- und Lehrer/Lehrerinneninterviews, Stundenberichte und Beobachtungsbögen

Mathematische Bereiche

Lineare Funktionen

Eingesetzte Technologie

Taschenrechner TI-Nspire

Beteiligte Autoren/ Autorinnen und Lehrer/ Lehrerinnen

Die fünf beteiligten Lehrer/Lehrerinnen hatten bereits Erfahrung mit dem Rechnereinsatz.

Experimentierzeit

Die empirische Untersuchung wurde in den Schuljahren 2006 bis 2008 durchgeführt.

Schüler und Schülerinnen

Drei 7. Klassen und zwei 8. Klassen an zwei verschiedenen Gymnasien, Erfahrungen mit Taschencomputern bzw. digitalen Medien im Mathematikunterricht waren vorhanden.

Dokumentation der Lehrer(innen)

Unterrichtsprotokolle

General objectives of the publication and public concern

Essential aspect of this research is the analysis of a self-developed learning environment, which conception is built on two main ideas: the initiation of self-regulated concept-formation-processes and the flexible use of several forms of representations to build up an expanded spectrum of imaginations. In the front of all there will be these questions.

Main results

From the point of view of the research

Not yet published

From the mathematical point of view

Not yet published

From the students' point of view

Not yet published

From the teachers' point of view

Not yet published

From the technological point of view

Not yet published

From the institutional point of view

Not yet published

The author's results and conclusion

Not yet published

3.3) Case Studies (Pilotprojekte)

Barzel, Möller 2001, summary

Reference of the publication

BARZEL, BÄRBEL; MÖLLER, REGINA (2001), About the use of TI-92 for an open learning approach to power functions. A teaching study. ZDM, Zentralbl. Didakt. Math. 33, No. 1, 1-5

Keywords

Calculators, Computer Algebra System, power function

Abstract

This article presents the results of a teaching study introducing the concept "power function" using a graphing calculator. The report illustrates the mathematical and social constructivist background together with a new deliberately constructivist approach beginning the teaching experiment with an open question. The students' cognitive and intuitive strategies and their attitudes towards computer algebra are described.

Type of publication

Article describing an instruction study, its theoretical background and its results

Design of the study

grade 9 classes (15-/ 16-year old), comfortable with TI-92 since six weeks

Instruments: data collection through individual explanations about the students' way of finding the solution, a documentation of their understanding, a questionnaire concerning the contents, the method and the documentation, a test, video recording of the lesson, observations; sequence of the teaching study consisting of group work and presentation;

Theoretical Framework: consists of three perspectives; 1) functional perspective: functional thinking (Vollrath 1989), concept images of functions (Dreyfus and Vinner 1985); 2) technological perspective: window shuttle-principle (Heugl, Klinger, Lechner 1996; 3) social constructivist perspective: individual's unique knowledge schemata (Davis et al. 1990), social constructivist (e.g. Edwards, Jones 1999)

Mathematics fields

Functions (power function), algebra

Technological Environment

Calculator TI-92

Authors and teachers involved

The author used to be a teacher and is now lecturer in Freiburg. She is not involved in CAS- or GC-experimentations at the moment.

Time of experimentation

The experiment took two whole lessons (90 minutes).

Students

Grade: grade 9 classes (15-/ 16-years old), number of students not defined

Documentation of teacher

Reports, observations during the lesson

Barzel, Möller 2001, Resümee

Quellenangabe der Veröffentlichung

BARZEL, BÄRBEL; MÖLLER, REGINA (2001), About the use of TI-92 for an open learning approach to power functions. A teaching study. ZDM, Zentralbl. Didakt. Math. 33, No. 1, 1-5

Stichwörter

Taschenrechner, Computer Algebra System, Potenzfunktion

Kurzfassung

In diesem Artikel werden Ergebnisse einer Unterrichtsstudie zum Begriff der Potenzfunktion beim Gebrauch eines grafikfähigen Taschenrechners präsentiert. Die Studie beruht auf einer offenen Unterrichtsgestaltung, deren theoretischer Hintergrund der Sozial Konstruktivismus bildet. Die kognitiven und intuitiven Strategien der Schüler zusammen mit ihrer Haltung zur Computeralgebra werden präsentiert.

Art der Veröffentlichung

Der Artikel beschreibt die theoretischen Grundlagen des Experiments, das Experiment selber und dessen Ergebnisse

Studienaufbau

Jahrgangsstufe 9 (15-16 Jährige), vertraut mit dem TI-92 seit sechs Wochen

Instrumente: Datensammlung durch individuelle Erklärungen der Schüler zur eigenen Ergebnisfindung, die Dokumentierung deren Verstehens, einen Fragebogen hinsichtlich des Inhalts, der Methode und Dokumentierung, einen schriftlichen Test, Videoaufnahmen während der Unterrichtsstunde, Beobachtungen; Unterrichtseinheit bestehend aus Gruppenarbeit und Präsentation

Theoretischer Hintergrund: 1) funktionaler Aspekt: funktionales Denken (Vollrath 1989), concept images of functions (Dreyfus and Vinner 1985); 2) technologischer Aspekt: window shuttle-principle (Heugl, Klinger, Lechner 1996; 3) Aspekt des Sozialen Konstruktivismus: individual's unique knowledge schemata (Davis et al. 1990), social constructivist (e.g. Edwards, Jones 1999)

Mathematische Bereiche

Funktionen (Potenzfunktionen), Algebra

Technologisches Umfeld

Taschenrechner TI-92

Beteiligte Autoren und Lehrer

Die Autorin war Lehrerin und ist nun Dozentin an der Pädagogischen Hochschule Freiburg.

Experimentierzeit

Der Zeitraum betrug zwei Unterrichtsstunden (90 Minuten).

Schüler

Klassen der Jahrgangsstufe 9

Dokumentation der Lehrer(innen)

Berichte, Beobachtungen während der Unterrichtssequenz

Barzel, Möller 2001, analysis

General objectives of the publication and public concern

The study focuses on the use of a specific question at the beginning of a teaching sequence about power functions. The interest is on how well it promotes the understanding of a new topic that is a new class of functions.

Main results

From the point of view of the research

A strong necessity was felt to further investigations into the role of technology in math education. The teachers also strongly need reassuring support to find a meaningful way of applying new media in their teaching endeavours and discussions of possible changes in the goals and contents of math classes.

From the mathematical point of view

N/A

From the students' point of view

The preliminary knowledge was sufficient. The pupils pointed out that working in collaborative groups was efficient and interesting. The opportunity to talk informally about mathematics was a big benefit for them. The students used decimal and rational numbers for the exponents and that the numbers differed only slightly. The students were very inventive with the titles of the posters: "Pictures with parabolas", "Root functions", "Functions", "Parabolas of all kind". The answers to the questionnaire after the sequence show evident differences between boys and girls.

From the teachers' point of view

The results of the instruction study were encouraging and prompted to transfer the social constructivist approach and its technology also to other mathematical topics. Students could operate with different representations. The students were always motivated and highly committed; they even forgot to take their break.

From the technological point of view

The use of the TI-92 was very much accepted by the pupils and they felt highly motivated. The boys' answers were even more positive than the girls'. The pupils found out for themselves how often and in which manner they used this medium. Positive: TI-92 does not take so much space; students utilized the calculator to prove their assumptions and their applied strategies; good tool for a "Trial-and-error strategy"; switching from one window to another one easily and therefore the connection between equation and graph was obvious to the pupils

From the point of view of classroom organisation

N/A

The author's results and conclusion

N/A

Bruder 2006, summary

Reference of the publication

BRUDER, REGINA (2006), Meaningful use of CAS in school -- a project report. (Sinnvoller Einsatz von CAS in der Schule - ein Projektbericht.), http://www.math-learning.com/files/TI_Abschlussbericht.pdf

Keywords

educational research; computer algebra; grade 11; teaching-learning processes; experience report; interviews; student attitudes; portfolios

Abstract

This article shows that after in total eight classes from grade 10, 11 and 13 had used a handheld calculator their acceptance towards new technology increased. There are first changes in the way of teaching and learning mathematics, especially concerning the support of communication and reflection of proceeding. Special didactical evaluation criteria were developed and used for portfolios of the lessons.

Type of publication

Article describing mainly results of the project and their interpretation

Design of the study

one grade 13 class, five grade 11 classes, two grade 10 classes at 4 different schools
Instruments: students' surveys before and after the project, documentation of the lessons, comments on used learning material from the teachers' and the students' point of view (portfolios)

Mathematics fields

N/A

Technological Environment

Calculator TI 200 Voyage

Authors and teachers involved

N/A

Time of experimentation

The project started in February 2005 and ended in July 2005

Students

One grade 13 class (18-/ 19-years old), five grade 11 classes (16-/ 17-years old), two grade 10 (15-/ 16-years old) classes at 4 different schools, in total: 198 students (110 female, 88 male)

Documentation of teacher

Portfolios

Bruder 2006, Resümee

Quellenangabe der Veröffentlichung

BRUDER, REGINA (2006), Meaningful use of CAS in school -- a project report. (Sinnvoller Einsatz von CAS in der Schule - ein Projektbericht.), http://www.math-learning.com/files/TI_Abschlussbericht.pdf

Stichwörter

Bildungsforschung, Computeralgebra, Jahrgangsstufe 11, Lehr-Lern-Vorgänge, Erfahrungsbericht, Interviews, Einstellungen der Schülerinnen und Schüler; Portfolios

Kurzfassung

Dieser Artikel zeigt, dass nach dem Rechnereinsatz in insgesamt acht Klassen die Akzeptanz von Taschencomputern deutlich zugenommen hat. Es sind bereits erste Veränderungen in der Art und Weise von Lehre und Lernen im Mathematikunterricht zu vernehmen. Es wurde didaktische Beurteilungskriterien für Unterrichtsportfolios zum Rechnereinsatz entwickelt und angewendet.

Art der Veröffentlichung

Artikel, der hauptsächlich die Ergebnisse des Projektes und deren Interpretation darlegt

Studienaufbau

acht Klassen, bestehend aus einer der Jahrgangsstufe 13 (18-/ 19-Jährige), fünf der Jahrgangsstufe 11 (16-/ 17-Jährige) und zwei der Jahrgangsstufe 10 (15-/ 16-Jährige), an vier verschiedenen Schulen

Instrumente: Schülerbefragungen vor und nach dem Projekt, unterrichtsbegleitende Dokumentation, Kommentierung der eingesetzten Lernmaterialien aus Schüler- und Lehrersicht (Portfolio)

Mathematische Bereiche

k/A

Technologisches Umfeld

Taschenrechner TI 200 Voyage

Beteiligte Autoren und Lehrer

k/A

Experimentierzeit

Der Modellversuch begann im Februar 2005 und endete im Juli desselben Jahres.

Schüler

Acht Klassen, bestehend aus einer Klasse der Jahrgangsstufe 13 (18-/ 19-Jährige), fünf der Jahrgangsstufe 11 (16-/ 17-Jährige) und zwei der Jahrgangsstufe 10 (15-/ 16-Jährige), an vier verschiedenen Schulen; insgesamt 198 Schülerinnen und Schüler (110 weiblich, 88 männlich)

Dokumentation der Lehrer(innen)

Portfolios

Bruder 2006, analysis

General objectives of the publication and public concern

Main aim: gaining transferable experiences and teaching materials, research about: acceptance and degree of contentment by both teachers and students, evaluating reasonableness of the use of CAS, effects of the use of CAS, presenting difficulties and open questions of teachers and learners in terms of the course and results of the project

Main results

From the point of view of the research

There were three main criteria to evaluate the portfolios written by the teachers: transparency of aim, description of process, quality of task

From the mathematical point of view

N/A

From the students' point of view

The survey was subdivided in four scales. There were negative tendencies in "self-perception and self-assessment", "design of the lessons" and "mathematical world view and valuation". Generally, the students gave a positive feedback wanting to work with CAS again. However, they want to retain the traditional way of teaching as well. Positive tendencies were found in the scale "support of communication and reflection of procedure"; *positive*: facilitation of mathematical application, opportunity to control, calculator can also be used in different subjects; *negative*: desire to understand mathematics better, sorrow of forgetting basic skills, fear of not understanding the calculator, confusing menu navigation, often appearing error messages, necessary commands have to be known by heart

From the teachers' point of view

Positive: central subject matters can be clarified better, so that students can understand important mathematical connections faster; calculator as tool for the demonstration of graphs and for the research of families of functions; improvement of the students' ability of presenting themselves and personal responsibility; fast and autonomous checking of results and ascertaining of approximations; increased use of complex tasks; *negative*: confusing display, hard error search, display sometimes distracts students; Generally, teachers give a favourable opinion to the use of CAS calculators.

From the technological point of view

N/A

From the point of view of classroom organisation

N/A

The author's results and conclusion

Main aim is to achieve a modern, interesting and diversified class, in which old and new methods are united as harmonious as possible.

Peschek, Schneider 2007, summary

Reference of the publication

PESCHEK, WERNER; SCHNEIDER, EDITH (2007). TI-Nspire im Mathematikunterricht – Kommentar zum Pilotprojekt aus fachdidaktischer Sicht. Klagenfurt, 94 S.

Keywords

Pilot project, TI-Nspire, Computer Algebra System

Abstract

This publication describes the way how pilot projects in Austria were arranged and accomplished. There were eight teachers involved and the publication shows five of their reports. They wrote about their lesson designs, the didactical issues concerning their lessons and about how it worked out in the end. Schneider and Peschek summarize the teachers' reports in almost twenty pages. The focus of these pilot projects was it to gain experience concerning the use of newly developed software TI-Nspire in maths classes.

Type of publication

Comment on pilot projects from the didactical point of view, describing and summarizing each pilot project and its results

Design of the study

grade 9 to 11 classes (aged between 14/ 15 and 17/ 18 years) on five different schools in Austria, 8 teachers

Instruments: documentation of class (aims, conception, use of TI-Nspire), of the design of lesson/ resources, of the realization of class (interesting results, results of the evaluation resulting from tests/ homework, interviews, surveys concerning the teaching unit); feedback/ assessment of colleagues at the same school

Mathematics fields

Functions and equations (linear, quadratic), trace figures via mathematical curves, calculation of compound interest and computation of annuities

Technological Environment

Handheld and computer-version of TI-Nspire

Authors and teachers involved

The eight teachers got didactical consultations for the concept and the annual planning as well as the detail plan for each teaching unit.

Time of experimentation

Academic year of 2006/2007

Students

Three grade 9 classes (64 students), one grade 10 class (22 students), one grade 11 class (unknown amount of students)

Documentation of teacher

1,5-days meeting, reports, portfolios, surveys

Peschek, Schneider 2007, Resümee

Quellenangabe der Veröffentlichung

PESCHEK, WERNER; SCHNEIDER, EDITH (2007). TI-Nspire im Mathematikunterricht – Kommentar zum Pilotprojekt aus fachdidaktischer Sicht. Klagenfurt, 94 S.

Stichwörter

Modellversuch, TI-Nspire, Computer Algebra System

Kurzfassung

Die Veröffentlichung beschreibt in Österreich durchgeführte Modellversuche. Von den acht beteiligten Lehrer(innen) gaben fünf einen Abschlussbericht ab, auf die in der Veröffentlichung näher eingegangen wird. Die Lehrer schrieben in ihren Berichten über die Unterrichtsplanung, die didaktische Umsetzung und darüber, wie die Stunden schließlich verliefen. Schneider und Peschek fassen die Lehrerberichte in fast 20 Seiten zusammen. Dabei liegt der Fokus dieses Pilotprojektes auf dem Sammeln von Erfahrungen im Umgang mit der neu entwickelten Software TI-Nspire im unterrichtlichen Einsatz.

Art der Veröffentlichung

Ein Kommentar zum Pilotprojekt aus fachdidaktischer Sicht, der jeden einzelnen Modellversuch und die dazugehörigen Ergebnisse beschreibt bzw. zusammenfasst

Studienaufbau

Jahrgangsstufe 9 bis 11 an fünf verschiedenen österreichischen Schulen

Instrumente: Dokumentation des Unterrichts (Zielsetzungen, Unterrichtskonzeption, TI-Nspire Einsatz), der Unterrichtsplanung/ Unterrichtsmaterialien, der Durchführung des Unterrichts (interessante Ergebnisse, Evaluationsergebnisse aus Tests/ Schularbeiten, Interviews, Fragebogen zur Unterrichtseinheit); Rückmeldungen/ Einschätzungen von Fachkolleg(inn)en der eigenen Schule

Mathematische Bereiche

Funktionen und Gleichungen (linear, quadratisch), Nachzeichnen von Figuren mittels mathematischer Kurven, Zinseszins- und Rentenrechnung

Technologisches Umfeld

Handheld und PC-Version von TI-Nspire

Beteiligte Autoren und Lehrer

Den beteiligten acht Lehrer(inne)n wurde fachdidaktische Beratung bei der Jahresplanung, der Unterrichtskonzeption und bei der Feinplanung einer Unterrichtseinheit angeboten.

Experimentierzeit

Schuljahr 2006/2007

Schüler

Drei 9. Klassen (64 Schüler(innen)), eine 10. Klasse (22 Schüler(innen)), eine 11. Klasse (unbekannte Anzahl von Schüler(innen)), alle sind zwischen 14/ 15 und 17/18 Jahren alt

Dokumentation der Lehrer(innen)

Berichte, Portfolios, Fragebögen, 1,5-tägiges Treffen

Peschek, Schneider 2007, analysis

General objectives of the publication and public concern

The study focuses on the collection of experiences concerning the use of the newly developed software TI-Nspire in class.

Main results

The numbers behind each statement only shows how many of the five reports said the same thing.

From the point of view of the research

There were no hints to the use of the TI-Nspire specific abilities. (4)

TI-Nspire specific abilities were used during the lessons. (1)

From the mathematical point of view

As the students learned how to find a solution manually first, they quite often decided, especially concerning quadratic functions, not to use the calculator because the manual way would be quicker. (1)

From the students' point of view

The survey focused on common issues and not at all on the use of technology in that particular lesson. (1)

From the teachers' point of view

The teachers' reflections base on commonly known statements, such as availability of different ways of finding a solution, opportunity to experiment. (1)

From the technological point of view

The calculator was mainly used as support for operative tasks, for calculating, for drawing graphs. (4) Remarkably, a method has to be learned manually first. (1) In one project the students studied slope triangles combining algebraic and geometric components. (1) There was a technical inadequacy observed (from the students' as well as the teacher's point of view). (1)

From the point of view of classroom organisation

N/A

The author's results and conclusion

The teachers had a positive attitude towards the use of technology and actually tried very hard to integrate it. However, they still have a rather conservative position in most cases. A lot of the didactical material and the design of teaching have to be overworked. The teachers keep to their traditional way of teaching.

Schmidt 2002, summary

Reference of the publication

SCHMIDT, KARSTEN (2002). The Use of CAS in the Thuringian School System: Present and Future, In: Borovcnik, M. und Kautschitsch, H. (Hrsg.), Technology in Mathematics Teaching, Wien

Keywords

CAS, survey

Abstract

This article presents results from a survey carried out in spring 2001, of all 336 secondary modern, 106 grammar and 5 comprehensive schools of Thuringia (Germany). This survey was preceded by a pilot project of all 26 secondary modern and 8 grammar schools in two Thuringian counties.

Type of publication

Article presenting results of a survey

Design of the study

336 secondary modern, 106 grammar and 5 comprehensive schools of Thuringia, 234 of the 447 schools filled out and returned the questionnaire

Instruments: a survey consisting of questions that had to be answered by ranking from 1 to 5 or by choosing answers given

Mathematics fields

N/A

Technological Environment

N/A

Authors and teachers involved

The head maths teacher from each school in Thuringia

Time of experimentation

The survey was carried out in spring 2001

Students

Did not participate

Documentation of teacher

Had to fill in the questionnaire

Schmidt 2002, Resümee

Quellenangabe der Veröffentlichung

SCHMIDT, KARSTEN (2002). The Use of CAS in the Thuringian School System: Present and Future, In: Borovcnik, M. und Kautschitsch, H. (Hrsg.), Technology in Mathematics Teaching, Wien

Stichwörter

CAS, Umfrage

Kurzfassung

Der Artikel stellt die Ergebnisse einer groß angelegten Umfrage dar, die im Frühjahr 2001 an allen 336 Realschulen, 106 Gymnasien und 5 Gesamtschulen von Thüringen (Deutschland) durchgeführt wurde. Die Umfrage ging einem Modellversuch an 26 Realschulen und 8 Gymnasien in zwei thüringischen Landkreisen voraus.

Art der Veröffentlichung

Artikel, der die Ergebnisse einer Umfrage veranschaulicht

Studienaufbau

336 Realschulen, 106 Gymnasien und 5 Gesamtschule von Thüringen, 234 von insgesamt 447 haben den Fragebogen ausgefüllt zurückgeschickt

Instrumente: eine Umfrage, die aus Fragen besteht, die entweder durch eine 5-stufige Rating-Skala oder durch die Wahl von bereits vorgegebenen Antworten beantwortet werden konnten

Mathematische Bereiche

Keine Angaben

Technologisches Umfeld

Keine Angaben

Beteiligte Autoren und Lehrer

Die Leitung der Mathelehrer von jeder thüringischen Schule war involviert, indem sie die Fragebögen ausfüllten.

Experimentierzeit

Die Umfrage wurde im Frühjahr 2001 durchgeführt.

Schüler

Keine Angaben

Dokumentation der Lehrer(innen)

Fragebogen

Weigand, Weller 2001, summary

Reference of the publication

WEIGAND, HANS-GEORG; WELLER, HUBERT (2001), Changes of working styles in a computer algebra environment. The case of functions, Intern. J. Comput. Math. Learn. 6, No. 1, 87-111

Keywords

Computer algebra systems (CAS), mathematical working styles, computer protocols

Abstract

This study is an empirical investigation of 11th graders at a German high school. Working over a 24-hour period in a computer lab, they investigated students' use of quadratic functions and trigonometric functions. While the students worked on the computer, their activities (such as inputs from the keyboard, menu choices or mouse movements) were saved by a special program.

Type of publication

Article presenting results of a testing period

Design of the study

different grade 11 classes at a grammar school

Instruments: computer protocols (students' actions were saved by the program 'Screencam')

Mathematics fields

Quadratic functions, trigonometric functions

Technological Environment

Derive, Mathplus

Authors and teachers involved

Weigand is researcher whereas Weller is a teacher.

Time of experimentation

24 hours of maths lessons

Students

Different grade 11 classes at a grammar school

Documentation of teacher

Two teachers were observing the students and taking notes.

Weigand, Weller 2001, Resümee

Quellenangabe der Veröffentlichung

WEIGAND, HANS-GEORG; WELLER, HUBERT (2001), Changes of working styles in a computer algebra environment. The case of functions, Intern. J. Comput. Math. Learn. 6, No. 1, 87-111

Stichwörter

Computer Algebra Systeme (CAS), mathematische Arbeitsweisen, Computer Protokolle

Kurzfassung

In diesem Artikel wird über eine empirische Untersuchung in verschiedenen 11. Gymnasialklassen berichtet. Dabei handelt es sich um eine 24-stündige Unterrichtsreihe zum computerunterstützten Arbeiten mit quadratischen und trigonometrischen Funktionen. Alle Bildschirmaktivitäten der Lernenden wurden durch ein spezielles „im Hintergrund“ laufendes Computerprogramm aufgezeichnet.

Art der Veröffentlichung

Artikel, der die Ergebnisse einer empirischen Untersuchung präsentiert

Studienaufbau

verschiedene 11. Gymnasialklassen

Instrumente: Computer Protokolle (Bildschirmaktivitäten der Lernenden wurden mit dem Program "Screencam" aufgezeichnet), Videoaufnahmen, Aufzeichnungen der Lehrer

Mathematische Bereiche

Quadratische und trigonometrische Funktionen

Technologisches Umfeld

Derive, Mathplus

Beteiligte Autoren und Lehrer

Weigand ist Forscher wohingegen Weller als Lehrer tätig ist.

Experimentierzeit

24 Unterrichtsstunden im Fach Mathematik

Schüler

Verschiedene 11. Gymnasialklassen

Dokumentation der Lehrer(innen)

Zwei Lehrer beobachteten die Schüler(innen) und machten sich Notizen dazu.

Weigand, Weller 2001, analysis

General objectives of the publication and public concern

Working with functions: How does the computer change students' working styles (comparing to traditional pencil and paper methods) when students are asked to find an equation of a function? *Using search strategies:* How does the expression-graph-interaction affect the development of search strategies when working with functions? *Reacting to computer feedback:* How does students' basic knowledge in mathematics affect their interpretation of the CAS feedback?

Main results

From the point of view of the research

There are different working styles: 1) solving a problem completely by working with 'paper and pencil' and the handheld calculator; 2) working only with the computer; 3) starting with 'paper and pencil' and then switching to the computer; 4) starting working with the computer and returning to 'paper and pencil' to solve special problems

From the mathematical point of view

A solution can be found in various ways.

From the students' point of view

Positives: computer graphics serves as a control mechanism for checking; Negatives: Difficulties in reading or interpreting the representations (underlining the importance of basic mathematical knowledge); danger of working only on a trial-and-error level without any reflections on alternative problem solving strategies or mathematical properties, difficulties in terms of faculty of abstraction for instance seeing a hill as a function

From the teachers' point of view

Role of the teacher: to take students' experimental computer experience, and to use that as a basis for consideration of the mathematical properties of the concept, *positive:* interaction between expression and graph supports working experimentally, *negative:* good knowledge is necessary in order to develop successful search strategies

From the technological point of view

Concentrating on the tool overrides other mathematical considerations.

From the point of view of classroom organisation

Partner work is useful.

The author's results and conclusion

Given a choice and the appropriate tool, students tend to move away from a formal or symbolic level towards a more graphically oriented level. Search processes are important activities on an intuitive level. Students did not get a better but a different understanding. Computer protocols are a useful research tool for studying the working styles of students as they go about solving problems, and for categorising problem solving strategies.

3.4) Resources based on experience ((Erprobte Unterrichtsmaterialien)

All documents you can find here are resources for the use of technology in maths, designed by the T³-Team Germany (Teachers Teaching with Technology). You can download these files from www.t3deutschland.de.

Alle hier genannten Dateien sind Unterrichtsmaterialien, die zum Einsatz von Technologie im Mathematikunterricht vom T³-Team Deutschland (Teachers Teaching with Technology) entwickelt wurden. Diese Dateien können unter www.t3deutschland.de heruntergeladen werden.

Autor	Titel	Jahr	Stufe	Technologie
Hugelshofer, René	Seiltänzerin	2008	Sek II	TI-Nspire™ CAS
Meyer, Berthold	MMM - Direkte Proportionalität	2008	Sek I, Sek II	TI-Nspire™ CAS/TI-Nspire™
Bruder, Regina; Weiskirch, Wilhelm (Hrsg.)	CAliMERO - Computer-Algebra im Mathematikunterricht. Band 3: Methodische und Didaktische Handreichung	2008	Sek I	CAS
Bruder, Regina; Weiskirch, Wilhelm (Hrsg.)	CAliMERO - Computer-Algebra im Mathematikunterricht. Band 3: Arbeitsmaterialien für Schülerinnen und Schüler	2008	Sek I	CAS
Bichler, Ewald	MMM - Median-Mean	2008	Sek I, Sek II	TI-Nspire™ CAS/TI-Nspire™
Keunecke, Karl-Heinz; Reiss, Angelika	Unterschiedliche Lösungswege für Extremwertaufgaben	2008	Sek II	TI-Nspire™ CAS
Hugelshofer, René	Kapitalwachstum	2008	Sek I, Sek II	TI-Nspire™ CAS/TI-Nspire™
Barzel, Bärbel; Pallack, Andreas; Schlöglhofer, Franz	Bilder analysieren und rekonstruieren	2008	Sek I, Sek II	TI-Nspire™ CAS/TI-Nspire™
Böer, Heinz	Regression und Korrelation	2008	Sek II	CAS
Pallack, Andreas	Vergleich verschiedener Modelle	2008	Sek I, Sek II	TI-Nspire™ CAS
Kaiser, Gerald	Schwingungsgleichung	2008	Sek II	TI-Nspire™ CAS

	eines elektromagnetischen Reihenschwingkreises			
Hugelshofer, René	Dynamik dank Variablen und Schiebereglern	2008	Alle	TI-Nspire™ CAS/TI- Nspire™
Schneeberger, Lucius	Eine Biogasanlage im Dampfkochtopf	2008	Sek II	CAS/CBL
Assmann, Ute; Becker, Kathrin; Liebner, Frank	Die Bergmannsche Klimaregel	2008	Sek II	CAS/CBL
Bischof, Markus	Frequenzmessung mit dem CBL2/LabPro	2008	Sek I, Sek II	CAS/CBL
Schlöglhofer, Franz	Aufnahme und Abbau eines Medikaments - ein mathematisches Modell	2008	Sek II	TI-Nspire™ CAS
Braun, Karl- Heinrich	Ballonfahrt - Eine Einführung in die Differentialrechnung	2008	Sek II	GTR
Frost, Norbert	Das vernetzte Klassenzimmer - Arbeiten mit dem TI-Navigator	2008	Alle	GTR/PC Software
Schmidt, Ulla	€-Münzen und pi	2008	Sek I	TI-Nspire™ CAS/TI- Nspire™
Böhm, Josef	Programmieren mit TI- Nspire CAS	2008	Sek II	TI-Nspire™ CAS
Schmidt, Karsten	Einführung in die Matrix- Algebra mit DERIVE	2008	Alle	CAS
Wonisch, Rainer	Parabeln und Co. erforschen mit TI-Nspire CAS (Handheld) - Lehrer- und Schülerheft	2008	Sek I	TI-Nspire™ CAS
Wonisch, Rainer	Parabeln und Co. erforschen mit TI-Nspire CAS (Software) - Lehrer- und Schülerheft	2008	Sek I	TI-Nspire™ CAS
Kutzler, Bernhard	Einführung in TI-Nspire CAS (Handheld)	2007	Alle	TI-Nspire™ CAS
Kutzler, Bernhard	Einführung in TI-Nspire CAS (Software)	2007	Alle	TI-Nspire™ CAS
Pallack, Andreas; Barzel, Bärbel	... aller Anfang ist leicht. Aufgaben mit TI- Nspire™/TI-Nspire™CAS	2008	Sek I, Sek II	TI-Nspire™ CAS/TI- Nspire™
Bruder, Regina; Weiskirch,	CALIMERO - Computer- Algebra im	2008	Sek I	CAS

Wilhelm (Hrsg.)	Mathematikunterricht. Band 2: Methodische und Didaktische Handreichung			
Bruder, Regina; Leuders, Timo; Büchter, Andreas	Mathematikunterricht entwickeln	2008	Alle	
Leinbach, Carl; Leinbach, Pat; Böhm, Josef	Forensische Mathematik für den Unterricht	2007	Sek II	CAS
Bichler, Ewald	MMM - Nullstellensatz	2008	Sek II	TI-Nspire™ CAS/TI- Nspire™
Bichler, Ewald	MMM - Abstandsproblem	2008	Sek I, Sek II	TI-Nspire™ CAS/TI- Nspire™
Buckel, Friedrich	Algebra Trainingsheft mit TI-Nspire CAS	2007	Sek I	TI-Nspire™ CAS
Nüesch, Walter	Funktionsbibliothek zur Raumgeometrie	2008	Sek II	TI-Nspire™ CAS/TI- Nspire™
Schuler, Hans	Der Voyage™ 200 als ökonomisches Hilfsmittel im täglichen Unterricht	2007	berufliche Schulen	CAS/Flash-Apps
Hugelshofer, René	Fibonacci-Folge	2008	Sek II	TI-Nspire™ CAS/TI- Nspire™
Pallack, Andreas; Barzel, Bärbel	Aufgaben mit TI-Nspire/TI- Nspire CAS - 2. vollständig überarbeitete Auflage basierend auf Version 1.2	2007	Sek II	TI-Nspire™ CAS/TI- Nspire™
Bruder, Regina; Weiskirch, Wilhelm (Hrsg.)	CAliMERO - Computer- Algebra im Mathematikunterricht. Band 1: Methodische und Didaktische Handreichung	2007	Sek I	CAS
Bruder, Regina; Weiskirch, Wilhelm (Hrsg.)	CAliMERO - Computer- Algebra im Mathematikunterricht. Band 2: Arbeitsmaterialien für Schülerinnen und Schüler	2007	Sek I	CAS
Klett- Verlag	Impulse Physik - Oberstufe (Neubearbeitung mit Schülersoftware)	2007	Sek II	CAS/CBL/CBR/GTR
Bruder, Regina;	CAliMERO - Computer-	2007	Sek I	CAS

Weiskirch, Wilhelm (Hrsg.)	Algebra im Mathematikunterricht. Band 1: Arbeitsmaterialien für Schülerinnen und Schüler			
Köcher, Jens; Koch, Kerstin; Liebner, Frank; Petlinski	Übungsheft CAS, Teil 2	2007	Sek I, Sek II	CAS
Birkholz, Marianne	Ganzrationale Funktionen	2007	berufliche Schulen	GTR
Kramer, Hans	Lösungsvielfalt und Vernetzung – ein Beispiel aus der Geometrie	2007	Sek I	GTR
Pichler, Heinz	Mit dem GTR zur politischen Bildung: Eine Wählerstrom-Analyse	2007	Sek II	GTR
Erens, Ralf; Winter, Dennis; Lausecker, Franziska	Prickelnde Mathematik – Modellierung für ein Sektglas	2007	Sek II	CAS
Salvisberg, Vera	Robotik mit dem WDSS von Vernier	2007	Sek II	CBL
Urban-Woldron, Hildegard	Messen-Visualisieren- Interpretieren-Modelle bilden	2007	Sek II	CBL/GTR
Lehmann, Eberhard	Nachhaltige CAS- Konzepte für den Unterricht	2007	Sek I, Sek II	CAS

4) Conclusion

Our conclusion is structured into two main parts. First of all, results of the mentioned researches are presented. Then a short prospect into the future concerning the use of calculators in maths in German speaking countries will be given.

In general, one of the most remarkable things noticed was that the role of the teacher in lessons using technology has modified enormously. The teacher does not take centre stage anymore but becomes a moderator who accompanies the pupils. Additionally, it was determined that the use of different teaching methods has changed. Both group and pair work was used much more frequently than it was before. Thirdly, especially the teachers themselves noticed that they had a different main focus in their maths classes. They emphasized interpretation and oral work much more than they used to do in teaching without technology. In the following detailed results will be illustrated briefly.

Main results

Very few longitudinal researches have been carried out in the German speaking area. This could be one reason why handheld computers in schools are not established sufficiently yet. Therefore handhelds should be introduced more presently and widespread. According to Weigand (2006) handhelds could be integrated in the regular 10th grade classes (15-/16-years old) and used in exams quite well.

The following criteria are crucial for good classes with the use of CAS, as said by Bruder (2006):

- transparency of the aim (which teaching and learning aims are pursued during the project),
- description of the process (how are the teaching and learning processes organized) and
- quality of tasks.

Via pre- and post test in both CAS classes and control classes could be determined that there are no differences in output at all between CAS classes and control classes when working with variable, terms and tables. (Barzel 2006, Weigand 2006 as well as Ingelmann, Bruder 2007b)

Furthermore, there persists a high potential for advancement of individualized learning, meaning a high potential for interior differentiation. (Barzel 2006, Bruder 2006)

In total, a positive feedback could be gained where the students would like to work with the calculators again. However, they emphasized that the traditional way of teaching should be maintained. (Barzel 2006, Bruder 2006)

Another positive consequence of using calculators is an implement increase of motivation and dedication. Unfortunately, there has been less increase of motivation and dedication in the German speaking countries if compared to others. (TI-Sonderausgabe) Furthermore, not only personal responsibility but also the students' ability of presenting themselves has improved. (Bruder 2006)

Results from the technological point of view

The training period of the teachers in Austria, Switzerland and Germany averaged between 3 to 8 weeks. Students needed about 4 to 12 weeks to get used to their new tool. (TI-Sonderausgabe)

A huge advantage was the opportunity of changing the connected displays of graphic, table and equation dynamically at the same time. The students can easily choose between various displays, discover variable ways of finding a solution and discuss. In the process some students have even found out their own way for problem solving. (TI-Sonderausgabe)

Another benefit is provided because graphics, tables and equations can be illustrated right next to each other and therefore, mathematical concepts can be explained from several points of view. Mathematical-symbolic expressions can be inputted and outputted in the familiar way. (TI-Sonderausgabe) The handheld calculator becomes an important tool for graphical illustrations and for the analysis of families of functions. (Bruder 2006)

The following deficits were mentioned in the researches: confusing display, confused menu navigation, error messages that frequently occur, necessary commands have to be known by heart as well as hard error search. (Bruder 2006)

Another disadvantage was found out by Weigand and Weller. Some students concentrate so much on the calculator as tool that they forget the mathematical content. They concentrate their attention on technical feature of the calculator which leads to inconsiderate actions as well as to press-the-button-activities. (2001)

Results from the mathematical point of view

CAS is appropriate when dealing with realistic questions which help to give an answer to the search of meaning in maths lessons. (Henn 1996)

Barzel (2006) found out that it is not an expenditure of time when integrating technology in an open – learning environment comparing to the traditional way of teaching. Following the results of the comparative post-test (with test items from ministerial comparative tests) you can see that pupils who learn in an experimental environment can succeed in the same way or even better than pupils who have learned the stuff in a classical way. The results of connected analysis of pupils' solutions of similar test items showed that pupils of the experimental group have a more flexible and effective use of representations than the pupils of the control group.

This result can be seen as a confirmation of various teachers' observations namely that a calculator could relieve enormously from trivial rearrangements of terms, syntactical transformations and numeric additional calculations. For this reason, there is more time left for developing, training and improving much more relevant skills and abilities. (Henn 1996)

Although, an increase of output could be discovered by Ingelmann and Bruder (2007b) in particular test items when comparing CAS and GC classes, they did not see significant differences between CAS and control classes neither in the pre nor in the post test.. For this reason, Bruder advocates an introduction of handhelds from grade 7 onwards because that is when beneficial preconditions could be found for the use of handhelds as supporting tools for the development of competence. (Bruder 2008)

Weigand and Weller (2001) observed in their research that mathematical basic skills are indispensable when handling a handheld calculator because otherwise the students would not be able to interpret their findings. Moreover, Bruder (2008) found out that important mathematical issues have to be repeated on a regular basis because students otherwise would not know it. Hence, the teacher would need to face an output decrease – independently from any use of technology.

Beside that, Weigand (2006) found out that a special importance is attached to the documentation of the learning processes describing the approach either in written or oral form and interpreting results given by the calculator. Additionally, CAS is the assistant when solving difficult or complicated calculations and rearrangements of terms. CAS allows to check assumptions quickly and does so provide assistance to the students (Henn 1996) In this connection it is important to take account of the learner's understanding and solving competence concerning mathematical operations before they actually are allowed to use CAS. The students are enabled to understand the context better and quicker.

Results from the students' point of view

Students experience maths lessons supported by the use of calculators as much more interesting and diversified (Barzel 2006, Weigang 2006). They can clearly point for what use the calculator has (Barzel 2006). Additionally, they enjoyed to get to know new sites of mathematics. (Weigang 2006)

They felt positive about choosing different ways of representation when thinking about the best way of finding the result of a specific mathematical problem. Furthermore, they could easily change the graphic and simultaneously observe the changes of the appropriate equation or table. Thereby, students can understand mathematics better. Another possibility of achieving a better mathematical understanding is the opportunity to see connections between graphs, tables and equations on the same display. This helps to solve mathematical problems. After the students have solved the problem they use the handheld especially in order to control and estimate their answers. So it is implicitly said that calculating manually does still have an important role and that the result with the computer will be controlled, but only after they actually found the result. (Barzel 2006, Bruder 2006, TI-Sonderausgabe)

More difficult and more realistic tasks can be solved via handhelds (TI-Sonderausgabe). At the same time, many mathematical practices are facilitated. (Bruder 2006)

CAS provides a special support when visualizing mathematical problems. That is an opportunity for each pupil to find their own method, their individual easiest way to understand a mathematical issue. (TI-Sonderausgabe)

Another advantage for the students was that the calculator cannot only be used in inner mathematical but also in outer mathematical issues. (Bruder 2006)

The students were not only worried about forgetting mathematical basic skills but also about not understanding the technology. (Bruder 2006)

It could be proved in different researches that especially weak pupils can increase their output when using a calculator. Hence, the expected effect of high-output pupils getting better and low-output pupils getting worse has not occurred. (Ingelmann, Bruder 2007; Weigand 2006)

Results from the teachers' point of view

Henn (1996) mentioned that working out of mathematical contents autonomously means team work. This connection is also pointed out by Barzel (2004) in her analysis about why the integration of technology comes along with an opening of classroom arrangements in the direction of pupil-oriented learning. Teachers need support and training in this field and it is important to give them examples for designing courses in such a sense.

In such courses, talking about mathematics must be initiated by special tasks and environments (Henn 1996).

Teachers recognized a significant change of class arrangements in maths lessons. Working in small groups, for instance, is experienced as very efficient. Students learn much more from each other and with each other. If an exchange of data is needed it occurs naturally and without any problems. Nevertheless, teachers are not only used as “final authority”. (TI-Sonderausgabe) Additionally, they have noticed that their role as a teacher has change. They now use the students’ experience gained by working with a calculator as basis for the consideration of mathematical contents. (Weigand, Weller 2001)

In general, a conservative opinion is expressed. In some cases you have to master mathematical operations manually as condition for using technology reliably. Besides, there exists a variety of didactical possibility which have only been used in small extent, for example: providing more (cognitive) room when outsourcing operations. (TI-Sonderausgabe)

Results from the point of view of classroom organisation

The handheld was proved as catalyst for new teaching methods like partner or group work which were claimed very often. (Weigand 2006) Teaching new methods leads to a better mathematical understanding. (TI-Sonderausgabe)

In respect of the use of calculators in examination one can say that the tasks do not differ much from the traditional ones. Besides, the variety of strategies of finding a solution and of controlling results increases when using handhelds during a test. (Weigand 2006)

The examples for lessons in the current school books are not appropriate to the use of technology. Unfortunately, there is still not enough motivation from teachers to develop appropriate examples. (TI-Sonderausgabe)

Prospect

This huge amount of aspects shows that handhelds are definitely an issue in the modern teaching of maths. Teachers show an interest to learn specifically about the way and dimension of change concerning the setting of priorities. There have to follow considerations about mathematical qualifications and aims which the students should achieve. The changed standards and aims in mathematics come along with the existence of new tools in many areas. (TI-Sonderausgabe)

According to Barzel (2006), the school is in charge of initiating, accompanying and evaluating learning processes. Due to contemporary knowledge, learning is only enduring when students can establish ties to intern networks of knowledge and structures. Learning has to be an individual, autonomous and constructive process. Although having this knowledge classes do barely change because the initiation of individual learning processes is perceived as time-consuming and incompatible with the curriculum.

All given researches make a contribution to a further development especially concerning maths lessons and will initiate thought-provoking impulses towards autonomous learning, against teacher-centred learning. The three areas – content, medium and autonomous learning – should be understood neither as additive demands nor as demands which are independent from each other (Barzel 2006).

At the moment there are various researches in progress which will be finished only in the following years. Some of them were mentioned above such as Bruder and Weigand. Another one is by Hußmann and Laakmann. However, they do not reveal any results yet. Other researches will start soon, for instance the CAYEN-project concerning the question about the

value of CAS when learning elementary algebra. The project is run by Barzel (University of Education Freiburg) and Drijvers (Freudenthal Institute, The Netherlands)

All mentioned experiments and researches clearly show that there is a movement concerning the work with calculators in maths classes.

Even so it will still take some time until CAS is finally established in German speaking schools. Indeed, a possible way of wide-spreading the use of calculators could be the integration through pilot projects as it is already being done in Austria, Switzerland and Germany. Currently, there are involved 78 schools in German speaking countries.

Schmidt reviewed in his survey from 2001 the situation in Thuringia (a German county). He found out that graphic calculators are not used at all and that symbolic calculators are only used at schools which participate in school development projects. Furthermore, there is known very little about both symbolic calculators and CAS. The most mentioned disadvantage was the reduction of the students' mental arithmetic ability. On the other hand, the second most named item was an advantage, namely that difficult calculations can be solved easily and quickly when using technology. In total, 60% of the teachers who have filled in the questionnaire see more disadvantages in the use of CAS or symbolic calculators in maths classes.

The main is consequently not only the wide-spreading of CAS but also the development of a modern, interesting and diversified teaching which combines "old" and "new" methods in an harmonious way. (Bruder 2006)

5) Answers to Burrill's questions based on the review of German research papers since 2000

Burrill's questions are taken from a study of 2002 American-led by Gail Burrill.

Question 1.

How do teachers use handheld graphing technology and how is this use related to their knowledge and beliefs about technology, mathematics, and teaching mathematics? What do teachers know and believe about handheld graphing technology and how is this related to their beliefs about mathematics and mathematics education?

The general mood concerning the use of calculators in the classroom in Germany is still actually pretty conservative. It depends on the county whether or not CAS or graphics are used. There are several counties where CAS can or even must be used in the final examination. Teaching in Germany, especially in maths lessons, is still very teacher-centred and therefore, the teachers, unfortunately, ignore the demands mentioned in the German curricula concerning the improvement of the pupils' competences and integration of technology.

Question 2.

With what kinds of mathematical tasks do students choose to use handheld graphing technology? How do students use the technology to carry out these tasks?

Barzel, Kleeberg (in progress, not yet published) analyzed tasks and teaching sequences in the frame of linear functions which are published worldwide especially for the use of technology in the classroom. They found out that the tasks which are used when an integration of technology occurred are still of the same format than which the tasks which have been used in a traditional, non-technology environment. There are only very few formats of tasks which differ when using GCs or CAS.

In contrast to that there are recommendations in the frame of research studies to change the tasks towards more opportunities of investigating, structuring and analyzing the mathematical objects (Barzel 2004, 2006). Weigand/ Weller (2003) point out that there is an danger of working only on a trial-and-error level, without any reflections on alternative problem solving strategies or mathematical properties. Some students in their research have created more than 50 graphs in half an hour which means they could not possibly have read or interpreted them. Teachers have to be aware of that and face the new challenge of teaching how to read and interpret the representations.

Question 3.

What mathematical knowledge and skills are learned by students who use handheld graphing technology? In what ways do students use this knowledge and these skills?

The students found out about new sides of mathematics. They could especially choose between different ways of representation, change the graphic and simultaneously observe the changes of the appropriate equation or table which enabled them to understand mathematics better. They have also learned to control themselves after having solved a problem. They have also realized how important basic skills and the use of them are.

Through the use of calculators students handle most of mathematical objects and they have a greater variety of representations for the same purpose. This flexibility is a good source for them to come along with mathematical problems and to structure their knowledge.

The students used their newly learned skills concerning the calculator especially when not dealing with mathematics. They, for instance, used their handhelds in other subjects as well.

Question 4.

What is gained mathematically by students using handheld technology that cannot be observed in a non-technology environment? In what ways do students use this knowledge and these skills?

A comparison analysis of pupil solution of a centralized test show that pupils which learned basic aspect of investigating functions with CAS and in a pupil-centered arrangement are much more flexible in applying their knowledge. For example in tasks in which pupils have to switch given graphs to given equations most of the pupils of the experimental group put an answer statement at the beginning in contradiction to pupils from control groups which put it at the end. (Barzel 2006))

Question 5.

What impact does handheld graphing technology have on the performance of students from the different gender, racial, socio-economic status, and achievement groups?

The German studies on calculators do not take into account neither gender nor ethnicity. The socio-economic issues are taken into account only marginally. So far, the focus of German researches has been on grammar schools which mainly persist of a homogeneous social background that does not include many different racial or socio-economic groups.

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