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COMPUTER-AIDED SEARCH FOR POINT SETS

INTRODUCTION

As a result of the giant strides which have been made by computing and communications technology since the second half of the Twentieth Century, the computer has started to play a role not only in informatics lessons but in other subjects as well. With the help of computer technology focussed teaching can be realised that is adaptable to the abilities of the individual student, since when doing exercises on the computer every student can make progress at their own pace, and teaching is thereby more efficient. Such teaching is characteristically pupil-centred, as compared to the traditional teacher-centred lesson.
According to case studies [2], when considering the performance in observed computer-supported scholastic activities and the experience in other lessons, there were such significant results that one can make a connection with the beneficial effects of creative activities on the computer.

These include:

- Patience and commitment: on the whole pupils working with computers strive for perfection.
- Possibilities for correcting mistakes: mistakes can be erased without a trace.
- Creativity, love of creation, self confidence.
- Self-sufficient learning and discovery.

The pupils take part in such activities with great enthusiasm and inner motivation.
In the teaching of geometry with the help of computerised drawing programs our aim is efficient presentation, by making precise and beautiful figures (since in many exercises it is difficult to create a truly expressive figure on the blackboard), to help better understanding, the development of creativity and thinking by the students and not least to make the lessons more interesting for those who do not like mathematics. We can do the simplest constructions in one step (for example the construction of a parallel through a given point to a given

line, or the construction of a mid-point of a section), thus leaving more time for the analysis of the problem and for formulating conjectures in a discussion period.

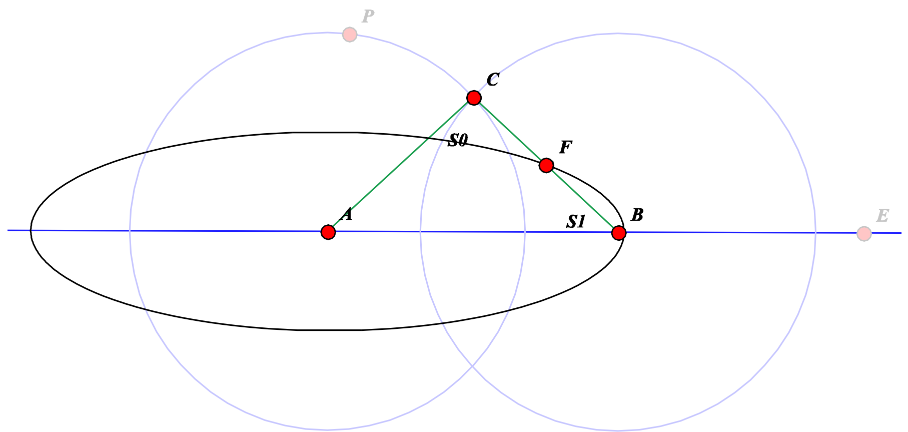
As regards construction programs in the field of dynamic geometry, besides the traditional constructions and the preparation of static figures, we can shift the fundamentals of the construction at will. The figure being drawn thereby changes consistently, since the program views the figure as a dynamic whole. Moreover, these systems can store the construction steps and execute them after modification of the input data. [4] We can run the program for one fundamental element on a line or circle containing it, and the dynamic geometry system can thereby sketch the path of the motion of a point dependent on the previous basic data: what's more if required this motion can be portrayed as an animation too, thus helping the evolution and development of the pupil's dynamic approach.

The most obvious possible application of dynamic geometry systems in the teaching of geometry is the finding of sets of points, the appropriate task in geometry. We will give an example of the completion of such tasks with the help of the *Cinderella* program. [5]

FINDING SETS OF POINTS

Example 1: Two rods of equal length are joined together at their common end-point *C*. The end point *A* of one rod is fixed. The end-point *B* of the other rod moves in a line passing through point *A*. We determine the geometrical locus of the midpoint of rod *BC*. ([3], 1397.) (Figure 1)

We arbitrarily put point *B* on the straight line passing through points *A* and *E*. Point *C* is equidistant from points *A* and *B* and we can find the point of intersection between these two circles (*C0* and *C1*) of equal radius. In order to determine the locus of point *F* the midpoint of section *BC*, point *B* must be selected as a moving object, whereupon the program automatically selects its path (the line).



A	Point(-1.08|2.84)	(-1.08|2.84)
E	Point(12.88|2.8)	(12.88|2.8)
e	Join(A;E)	y = -0x + 2.84
B	PointOn(e;(6.49|2.82))	(6.49|2.82)
P	Point(-0.52|7.96)	(-0.52|7.96)
C0	Circle(A;P)	(x + 1.08)2 + (y - 2.84)2 = 5.152
C1	Compass(A;P;B)	(x - 6.49)2 + (y - 2.82)2 = 5.152
C	Intersection(C0;C1)	(2.72|6.32)
S0	Segment(A;C)	_
S1	Segment(C;B)	_
F	Mid(C;B)	(4.60|4.57)
C2	Locus(B;e;F)	0.07x2 + 0.65y2 + 0xy + 0.15x - 3.67y + 1 = 0

Figure 1. 1397.

The children first express their conjectures about what the point set will be and than give reasons for their conjectures. They do not conjecture just on the basis of the given figure that this is all about an ellipse: they recognize the equation of the ellipse from writing out the list of constructions, and are thus motivated to look for it themselves.

Example 2: We draw a circle round point *O* and fix one of its diameters. We choose a point *P* on the circumference of the circle. Let *Q* be the perpendicular projection of *P* on to the fixed diameter. We measure the length *OR*=*OQ* of a line drawn from the centre to point *P*. We determine the locus of *R* as *P* moves round the circle. ([3], 1431.) (Figure 2)

In order to determine the locus of point *R*, point *P* must be selected as a moving object: the program automatically selects its path (the circle).

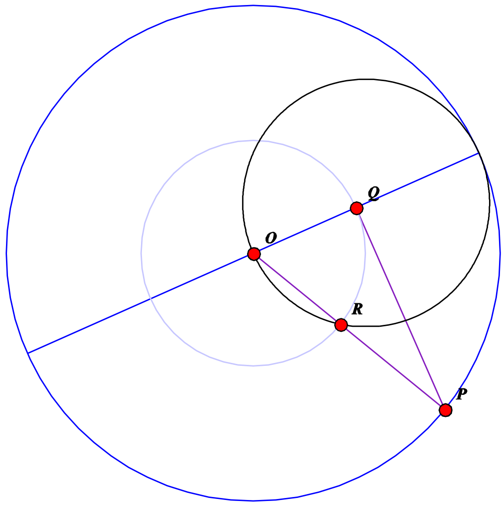


Figure 2. 1431.

Example 3: We fix point *A*(*x0; y0*) on the plane of a coordinate system (*x0>0* and *y0>0*). We draw a line *e* through point *A* which cuts the *x* axis at *Q* and the *y* axis at *R*. We determine the locus of the midpoint of the section *QR* as the line *e* moves around point *A*. ([3], 1432.) (Figure 3)

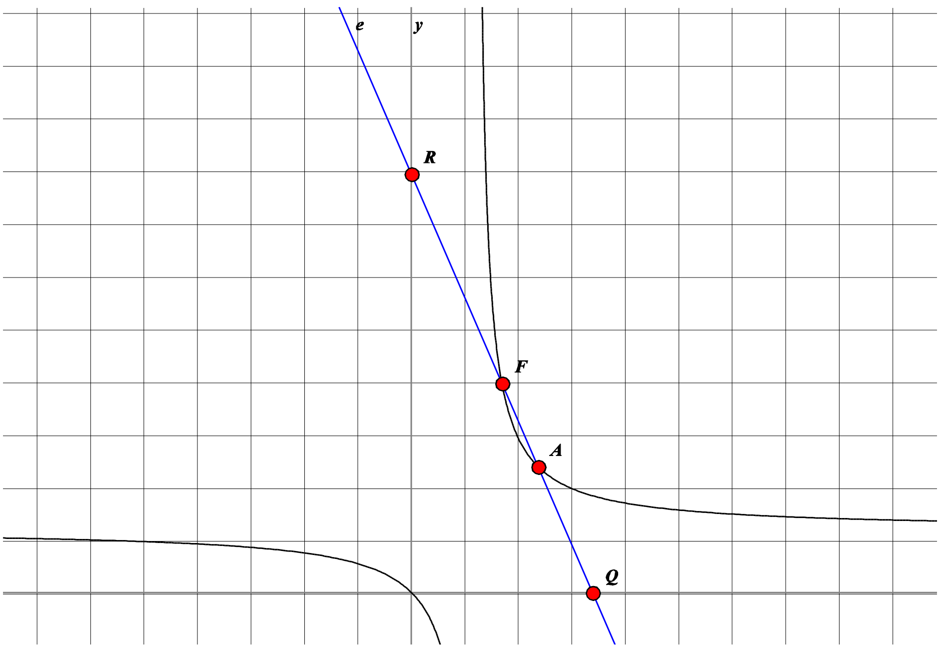


Figure 3. 1432.

On the figure we find point *F* by construction of the midpoint of the section *QR*. In order to determine the locus we select the line *e* as a moving object and the program automatically selects point *A*, around which we move.

By the solution of these examples, the fundamentals of development of problem-solving ability according to Wittmann [1] can be realized since the acquisition of knowledge proceeds by means of exploratory learning with the help of the computer, and the pupils take up the problem themselves and the exclusive employment of automatic thought processes is kept in the background (for example there is a difference between the basic object which we moved around (the point on the line) and its path (circle, line)). Before and during the problem solving activity we encourage the children to use intuitive justification, conjecture and independent work.

SUMMARY

Preparation of the lessons on the computer demands far more time than in the case of traditional practice. The use of the programs is by no means difficult and can be mastered easily and quickly. Suitable use helps well in the mastery of knowledge and in the understanding of the notions and relations. On the basis of the evidence of case-studies [2] not only does the felicitous use of the computer convey useful theoretical and practical knowledge, it can to a certain extent contribute to mental development too.

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SZÁMÍTÓGÉPPEL SEGÍTETT PONTHALMAZKERESÉS

A XX. század második felétől az információs és kommunikációs technika rohamos fejlődésének hatására a számítógép egyre több iskolában a számítástechnika órákon túl szerepet kap más tárgyak tanításában is.
A dinamikus geometriai rendszerek legkézenfekvőbb alkalmazási lehetősége a geometria oktatásában a ponthalmazok keresése, a mértani helyes feladatok. E rendszerekben lehetőség van arra, hogy egy alapelemet végigfuttassunk egy azt tartalmazó körön vagy egyenesen, majd ennek hatására a dinamikus geometriai rendszer egy (az előbbi alapelemtől függő) pont mozgásának pályáját megrajzolja, sőt akár ezt a mozgást animációként is megjeleníti, így segítve a tanulók dinamikus szemléletének kialakulását, fejlődését.