Research on Implementing the Core Literacy of IntuitiveImaginationinSeniorHighSchoolMathematicsTeaching

ABSTRACT: Intheprocessofseniorhighschoolmathematicslearning,improvingstudents'intuitiveimaginationcoreliteracycanenhancetheirabilitytocombinenumbersandshapes.Italsoplaysanimportantroleindevelopinggeometricintuition,spatialimagination,andunderstandingtheessenceofthings.Wefirstsummarizethecurrentstrategiesforcultivatingthecoreliteracyofintuitiveimagination,thenprovideanoverviewoftheintuitiveimaginationincoreliteracy.Theauthorinterviewed12seniorhighschoolmathematicsteacherswhowereteachinglocallyinvariouscitiesinShandongprovincewithalargepopulationandbalancededucationlevels.Throughinterviews,itislearnedthat,studentsalwayslacknumericalevidencewhendoingexercises,andmoststudentsonlylookatquestionswithoutsketching.Duringteaching,teacherscloselyfollowthetextbookbutlackexplanationofflexibleproblem-solvingmethodsusinggeometry, andtheymayexperienceimproperuseofteachingaidsorincoherentexplanations.Finally,correspondingstrategiesare provided.

Keywords: CoreLiteracy;Intuitive Imagination;Senior HighSchoolMathematicsTeaching

1.INTRODUCTION

IntheGeneralSeniorHighSchoolMathematicsCurriculumStandards(2017Edition, 2020Revision),sixcorecompetencieswithcohesionareclearlyproposed,including mathematicaloperations, mathematicalabstraction,mathematicalmodeling,logicalreasoning,intuitiveimagination,anddataanalysis[1]. Amongthem,intuitiveimaginationisanimportantmeansofdiscoveringandposingproblems,analyzingandsolvingproblems.Itisalsothe thinkingfoundationforfor

mingargumentativeideasandconstructingabstractstructures.Thecombinationofnumbers andshapes,aswellastheabilityofintuitiveimagination,playsasignificantroleinhelpingstud entsunderstandtheessenceofthings.Therefore,howtoimplementthecoreliteracyofintuitiv eimaginationinseniorhighschoolmathematicsteachingisamajortask.

Currently, therearemanystudies onthecultivationstrategiesofintuitiveimaginationcoreliteracyinChina, andthevastmajorityofthemexpressedcorresponding viewsthroughstatisticalanalysisofquestionnairesurveyresultsorbasedonteachingincasec lassrooms.Forexample,YunfeiHuthinksthatweshoul dnotonlyattachimportancetostudents'dominantpositiontomobilizetheirinitiative,butalso totheunderstandingandtransformationbetweenwords,graphicsandsymbols,andtheirintui tiveperception[2].XuejingZheng,QinghuaChenandothersthinkthatitisnecessarytocoordi natethedevelopmentofintuitiveimaginationandlogicalreasoning,cultivateahigherlevelof intuitiveimagination,payattentiontotherelationshipbetweenintuitiveimaginationandothe rcoreliteracy[3].XuefenBeibelievesthatitdependsonthecombinationofnumbersandshape s,withthehelpofmathematicalmodelandinformationtechnology,innovativeteachingmeth ods[4].DetongXuandYunxiangQianthinkthatitisnecessarytostrengthentheteachingof"dr awingpicturesaccordingtothedescriptionoflanguage" andstudythecognitivelaw[5].

Atpresent,thesestudiesmainlyproposedrelativelycomprehensiveandrelevantstrategiesf orcultivatingcorecompetenciesinintuitiveimaginationthroughquestionnairemeasureme ntresultsorclassroomteachingcharacteristics.Ithascertainscientificbasis,butlessconsider ationisgiventoin-
depthanalysisoftheconnotationofcorecompetenciesandconductingcorrespondingintervi ews.Thispaperwillfocusontheanalysisofthedefinition,requirementsandperformanceofth ecoreliteracyofintuitiveimagination.Thenthroughinterviewswithsomein-
serviceteacherscombinedwiththemoreappropriaterealexperienceandfeelingsof front-
lineteachers,correspondingstrategieswillbe putforward.

2.INTUITIVELYIMAGINETHECONNOTATIONOFCORELITERACY

2.1 Intuitivelyimaginethedefinitionofcoreliteracy

Intuitiveimaginationreferstotheliteracyofperceivingtheshapeandchangeofobjectswithgeometricintuitionandspatialimagination,understandingandsolvingmathematicalproblemswithspatialforms,especiallygraphics.Geometricintuitionreferstotheabilitytodirectlyperceiveandgraspthemathematicalresearchobjectwiththehelpoftheimagerelationshipofgeometricimagesseenorimagined[6].Spatialimaginationreferstothereappearanceandreconstructionofobjectivethingsinindividualmindsaftermathematicalabstraction[7].Perception isthefeelingand
perceptionofthings.Theformandchangesofanobjectrefertothesize,shape,state,andchangesthatoccurintheseaspectsoftheobject.Spatialformreferstotheconcretemanifestationsofobjects,suchastwo-dimensionalgraphicsandthree-
dimensionalgeometry.Mathematicalproblemsareproblemsrelated
tomathematicalknowledge.

Therefore,intuitiveimaginationreferstousinggeometricintuitionandspatialimagination tofeelthesize,shape,state,andchangesthatoccurintheseaspectsofthings.The abilitytoutilizethespecific formsof objects,especiallytwo-dimensionalgraphics,tounderstandandsolvemathematicalknowledgerelatedproblems.

2.2 Intuitivelyimaginethecontentrequirementsofcoreliteracy

2.2.1 Understandthepositionalrelationship,morphologicalchangesandmotionlawsofthingswith thehelpofspatialforms.

Positionrelationshipisarelativeconceptthatencompassesawiderangeofcontentsingeometry,suchasparallelism,intersection,perpendicularity,anglesfor

med,distanceinsolidgeometry.Thelawofmotionreferstothelawthatanobjectfollowsinthepr ocessofmotion,suchasthecentralsymmetricalfigurerotates180aroundthecenterandcoinci deswiththeoriginalfigure.Thisrequiresstudentstousethespecificformsofobjectstounderst andtheorientation,distance,size,shape,state,aswellastheirchangesandchangingrelations hip

s.

2.2.2 Usingimagestodescribeandanalyzemathematicalproblems

Descriptionistodescribetheproblemvividlyaccordingtoitscharacteristics.Analysisistofi ndouttheessentialattributesoftheproblemandtherelationshipbetweenthem.Thisrequires studentstofullyunderstandthecharacteristicsofimages,beabletovividlydepictmathemati calproblemsandfindouttheiressentialattributes andrelationships.

2.2.3 Establishtherelationshipbetweennumberandshape,buildanintuitivemodelof mathematicalproblems, andexplorewaystosolveproblems.

Numberandshaperefertoquantitativerelationshipandspatialformrespectivel y. Intuitivemodelrefersto acomprehensiveapproachthatusesfamiliarandobservablegraphicstorepresenttherelatio nshipstructureofaproblem.Itcanconcretize abstracttheories,demonstratedynamismandintuitiveness.Requirestudentstoconnectthro ughquantitativerelationshipsandspatialforms,inordertoconstructafamiliarandobservabl erelationshipstructureformathematicalproblems,soastograsptheessenceofproblemsand findsolutionstothem.

2.3 Intuitivelyimaginetheperformanceofcoreliteracy

2.3.1 Establishtherelationshipbetweennumberandshape

Asthecornerstoneofmathematicalcontent,quantitativerelationshipandspatial

formhaveacertaintransformationrelationship.Strengtheningtherelationshipbetweennumbersandshapescan,ontheonehand,clarifysomepropertiesofgeometrybyusingtheaccuracyofnumbers,andontheotherhand,revealsomerelationsofnumbersbyusingtheintuitionofimages.AsMr.LuogengHuasaid,itislessintuitive whenthe numberismissing,anditisdifficulttobenuancedwhenthenumberis missing [8].

2.3.2 Usinggeometricimagestodescribeproblems

Geometricimagereferstothefigureabstractedfromthephysicalobject.Withthehelpofthere lationshipbetweennumbersandshapes,manymathematicalproblemsinvolvinggeometry canformcorrespondingimagesbasedonthegiventextandnumbers,achievingatransformation fromabstracttointuitive.
Usinggeometricimagestodescribeproblemsisalsounderstoodasusingthevisualrelationships of geometricshapestodescribe abstractandcomplexproblems.

2.3.3 Understandtheproblemintuitivelywithgeometry

Explanatorynotesofgeometricintuitionrefertotheuseofgraphicstodescribeandanalyzepr oblems,andgeometricimagestodescribeproblems.Utilizegeometricintuitiontoperceivet hequantitativerelationshipsandspatialformsofresearchproblemsasawhole,inordertogras ptheessentialcharacteristicsoftheproblem.Makecomplexmathematicalproblemsvivid,e xploresolutions,predictresults,and gainaprofound understandingoftheproblem.

2.3.4 Understandingthingsbyusingspatialimagination

Comparedtogeometricintuition,spatialimaginationhighlightstheabilitytoimaginetheshap esandrelationshipsofshapesevenwithoutacertainbackground.Intermsofcontent,italsoem phasizestheunderstandingofthemotion,variation,and positionalrelationshipsbetweentwo-dimensionaland three-dimensional

geometricshapes.Therefore,wecan usespatialimaginationtounderstandtheposition,shapeand motionstateofthings.

3.THEANALYSISOFTHECURRENTSITUATIONOFTEACHING

Inordertogetadeeperunderstandingofthecurrentlearningandteachingsituationofstudents andteachersin thecoreliteracyofintuitiveimagination,interviewswereconductedwith12seniorhighscho olmathematicsteachersfromvariouscitiesinShandongprovincewhichhasalargepopulatio nandarelativelybalancededucationlevel. Theintervieweeswereyoungteachersonthefrontline,sotheinterviewcontentwasrepresent ativeandauthentic. Theseinterviewsweremainlytounderstandtheproblemsexisting instudents'learningandthedifficultiesencounteredbyteachersin theteachingprocess.

Theinterviewcontentwasdividedintofoursmallquestions,eachofwhichwascontrolledwit hin3minutes,andthelogicwassmooth.Theinterviewwasrecordedandanonymous.Thetopi csoftheinterviewwereasfollows:(1)Whatdoyouthinkisthemainreasonthatstudentsmake mistakesorcan'tanswerintuitiveimaginarymathquestions?Pleaseelaborate.(2)Haveyouf oundanyimproperorerror-pronehabitsintheprocessofobservingstudents'classesorsolvingproblems?Ifyes,pleaseex plainindetail.(3)Whatisthemainbasisforyoutoexplainthecontentofintuitiveimagination mathematicsinclass.Doyouthinkitisenough?Ifnot,whatcontentshouldbestrengthened?(4)Willtherebe a teachingjamwhenyouexplainthe contentinclass?Ifso,whatdoyouthinkis themain problem?

Bylisteningtoandrecordingtherecordingsofeachanswerofthese12teachersmanytimes,th ecommonviewsofmostteachersoneachquestionweresummarized,andthefollowingstatus quowasobtainedthroughsortingoutandanalyzing:

3.1 Studentssometimesrelyonfeelingstodoproblems,andlackofdigitalreasoning.

Thevastmajorityofteachershavedescribedthatwhenmanystudentsansweredsomemathproblemswithimages,theywouldtakeforgrantedwhattheysaworthoughtasafactwithoutanyreliablebasis,andthefinalresultwasobtainedunderthisunreasonablepremise.Insomegeometryproblems,thechangesandtransformationsofimages,aswellastheadditionofauxiliarylines,requirestudentstoexpandtheirimaginationandconstantlytryandmakemistakes.However,theprocessofreasoningandproofmustbebasedontheclearnumbersinthequestionstem,followingexistingrelevanttheorems,andgraduallyderivingthemstepbystep.Mathematicsisaveryrigoroussubject.Itisextremelyunreasonabletojumptoconclusionsbasedonfeelingsandlacklogicwhensolvingproblems.

3.2 Studentswillonlywatchandnotdrawwhendoingclassactivitiesorproblems.

Afterinterviews,manyteacherstalkedaboutthephenomenonthatmanystudentsjustlookedatthetopicwiththeireyesopenandhungtheirhandsasideduringdrawingormathproblem-solvingactivitiesinclass.Nottomentionthattherewillbenowaytostartwhensolvingmorecomplicatedtopics,andevensomesimpletopicswillnotberepresentedbydrawingimages,letalonetalkingaboutthestepsofwritingastandardizedsystem.This"lazybehavior"ofstudentswhoonlylookatpicturesseriouslyaffectsthedevelopmentofstudents'intuitiveimaginationability.Italsoreducesstudents'abilitytounderstandthenatureofgraphicsanddrawgraphicsskills.Formathematics,asubjectthatfrequentlyusesgraphics,itisimportanttobefamiliarwiththepropertiesofgraphicsandmastertheskillsofdrawing.Thebehaviorofonlylookingatmathematicalproblemswithout drawingbyhand isdefinitely opposed.

3.3 Teachersticktotextbooksinteaching,butseldomexplainhowtosolveproblemsskillfullywiththehelpofgeometry.

Abouttheirteachingsituation,mostofteachersadmittedthatwhentoldstudentsabouttheirknowledge,theymostlyexplaineditaccordingtothecontentsandexamplesintextbooks.Therewererelativelyfewexpandedcontents,especiallytheflexibleuseofvariousgraphicskills.Thephenomenoncausedbythiswasthatstudentswouldfeelcomfortableafterlisteningtotheteacher'slecture,andtheexamplesinthetextbookwereeasytosolve,buttheyfounditmorediffic ulttopracticeortestquestionsonthetestpaper.Studentswillbefamiliarwithsomequestionsthatdirectlyapplyknowledge,andwillbeatalossforsomequestionsthataredifficulttosolveinaconventionalwaybutcanbeexpressedsimplythroughgeometricimages.Notsummarizingmethodsforflexiblyapplyingimagesmakesitdifficulttoimprovestudents'mathematicalproblem-solvingability.Mathematicsisasubjecttoteststudents'thinkingabilityandimaginationabilities.The flexibleapplicationofgeometryinthedevelopment ofstudents'abilitiescannotbeignored,althoughtheexplanationofbasicknowledgeis also important.

3.4 Teachersmaynotusepropermodelsorlackcoherentexplanationsingeometryteaching.

Itis learnedfromtheinterviewthatmanyteacherssometimes usemodels thatstudents donotunderstandverywellandthisfailtoorganizeproperlycohesivetermsorsentencesinexplainingtheevolutionofnewobjectsingeometryteaching.Whenstudentsfaceunfamiliarobjects,theirthoughts areever-changing.Everyonehashisorherownlifeexperience,andthereis norelativelyuniformstandardatall.Intheprocess,anewconceptofobjectssuddenlypopsupforstudents,whichmakesstudentsunabletograspthespecificshape,sizeandpositionrelationshipofobjects,nottomentiontheirimportantcharacteristics.Nomatterhow goodthestudents'spatialimaginationis,theycannothave

aclearrepresentationofthegraphics,understandthepositionrelationshipandmotionstateof thegraphics.Therefore,itisnotadvisableformiddleschoolteacherstouseinappropriatemod elsorlackcoherentexplanationsingeometryteaching.

4.STRATEGIESFORIMPROVINGCORELITERACYININTUITIVEI MAGINATION

4.1 Emphasisisplacedonsolvingmathematicalproblemsbycombiningthenumbersi ntheconditionswith thegivenfigures.

Inviewofthethinkingusedbystudentsinsolvingproblems,teachersshouldteachstudentstop ayattentiontocombinethenumbersinthequestionswiththegivenfigures,ratherthanrespond ingparadoxicallybyfeeling.Thegraphicsgiveninthequestionprovideaframework,whichis onlyusedasareference.Ifitlookslikeit,itmaylackmathematicalrigor.Payattentiontocombi nethenumbersgivenintheimageandconditionswhenexplainingtheproblemideas.Usingim agesasareference,startingfromnumericalcalculations,followinggeometrictheoremstocal culatecorrespondingquantitiestoprovideclearevidence,andfinallydeterminingthepositio nandinterrelationshipsofobjects.Forexample,tosolvethepositionalrelationshipbetweent wofacesinacube,aspatialcoordinatesystemcanbeestablishedtoobtainthenormalvectorsof thesetwofaces.Bycalculatingthepositionalrelationshipbetweenthesetwonormalvectors,t hepositionalrelationshipbetweenthetwofacescanbeinferred.Thi snotonlyhelpstostrengthenstudents'thinkingofcombiningnumberswithshapesbutalsoen ablesstudentstorealizethecloserelationshipbetweennumbersandshapes.

4.2 Cultivateandencouragestudentstodrawcorrespondingimages whensolvingmathematical problems.

Forthephenomenonthatstudentsonlylookattheproblemsbutdonnotdraw,teachersshouldfocusoncultivatingandencouragingstudentstodrawpicturestosolveproblemsinclassroomteaching.Ifstudentsonlylookatthepicturesbutdonnotdrawthem,theyjuststayintheunderstandingofabstractnumbersandhavenounderstandingofthegeometriccontentcontainedinthem.Whenexplainingexampleproblemsinclass,demonstrateaclear drawingprocessandstrictlyrequirestudentstopracticeittocultivatethehabitofdrawing.Whensolvingproblemsafterclass,studentsshouldbeencouragedtotrydrawingpicturestodescribetheproblem.Forexample,intheprofitproblem,aquadraticfunctionislistedbasedontherelationshipbetweenthegivensellingprice and thesolditems.Basedonthis,agraphofthequadraticfunctioncanbedrawntodescribethebasicsituationoftheproblemthroughthegraph.Itcannotonlystrengthenstudents'understandingofimagesbutalsotoimprovestudents'useofgeometricimagestodescribeproblems.

4.3 Payattentiontotheinductionandsummaryoftheidea ofusinggraphicsto analyzeproblems.

Inviewofthefactthatmostteachersexplaintheexamplesandexercisesoftextbooksinclass,teachersshouldpayattentiontosummingupandsummarizingtheskills andideasonhowtoanalyzeproblemswithgraphics.
Althoughstudentshaveasolidgraspofthebasicknowledgeintextbooks,theywillnotbeabletothinkofideasforawhilewhentheyencountercomprehensiveortransformationaltopics.Sometimes evenracktheirbrainstothink fruitlessly. Atthispoint,theteacherneedstosummarizesomekeyandsimilarquestions,andsummarizethecorrespondingideasforusinggraphicstoanalyzeproblems. Whenexplaining exercises,focusonanalyzingmethodstohelpstudentsmastercertainproblem-solvingskillswhilefamiliarizingthemselveswithbasicknowledge.Studentswillalsobeabletohandlesimilaroreveninnovativeproblemswithease.Forexample,whensolving theinequality problemofaquadraticequation,wecandrawitsimage,andthenusetheinformationsuchasthe intersecti

onoftheimageandtheX-axisto analyzetheinequality, thatis,thevaluerangeoftheroot,whichmakestheproblemeasytounderstand[9]. Thiscannotonlystrengthenstudents'abilitytodescribeandanalyzeproblemswithimagesbu talsoexploreideas,predictresultsanddeeplyunderstandproblems.

4.4 Usethefamiliarandcharacteristicteachingmodeltoexplainstepbystep.

Teachersshouldmakeproperuseofstudents'commonandqualifiedteachingmodelsinteach ing,andfollowstudents'cognitiverulesinexplainingstepbystep.Ifteachersdonotuseappro priateteachingmodels,itcanleadtostudentsnothavingaclearandsystematicrepresentation ofshapesorgeometricbodies,resultingininconsistentunderstanding.Incompleteundersta ndingmakesitdifficulttoconductlectures,andatthesametime,itisevenmorechallengingtod oexercises.Infact,beforestudentsentertheclassroom,theyalreadyhaveanunderstandingof externalthingsintheirbrains.Inclassroomteaching,teachersshouldchoosedailynecessities thatstudentsarefamiliarwithasmuchaspossibletoreducestrangeness.Atthesametime,itisn ecessarytostrictlymeettherequirementsandcharacteristics,doagoodjobintheevolutionof knowledge,letstudentsthinklayerbylayer,andfinallyformaclearunderstandingoftheshap e,size,andpositionofobjects.[10].Whenexplainingrectangles, diamondsandsquares,wecanmakefulluseofthedoorframes,telescopicdoorsinourlivestoh elpstudentsbetterunderstandtheircharacteristicsandpropertiesandformaclearrepresentat ion.Itcannotonlyimprovestudents'spatialimaginationabilitybutalsostrengthenstudents'u nderstandingofvariousattributessuch asobject motionstatesinthefuture.

5.Conclusion

Tosumup,theall-rounddevelopmentofstudentsistheultimategoalofeducation,andthecultivationofcore literacyplaysa keyrole inthe all-rounddev

elopmentofstudents. Asanimportantcontentofcoreliteracy, teachersshouldstrengthenteachingresearch,carefullystudytheconnotations,requirements,andexpressionsofintuitiveimagination.Itisevenmoreimportanttoemphasizethatstudentsshoulduseacombinationofnumbersandshapestosolveproblems,cultivateandencouragethehabitofdrawing,summarizetheideaofusinggraphicsto analyzeproblems,andexplainthemstepbystepwith appropriatemathematicalmodels.

Butatthesametime,therearestillmanyshortcomings.Thequestionsaboutthecoreliteracyofintuitiveimaginationarewideinscopeandnotpreciseenough.Wecanmakemoretargetedanalysisofthespecificchaptersofhighschoolknowledgeand givecorrespondingstrategies.By theway,wehopetofurtherexplorethepsychologicalmechanismsofstudentsindrawingandnotdrawingwhensolvingproblemsinfutureresearch.Therefore,itproposesstrategiestoimprovestudents'coreliteracyofintuitiveimaginationandbetterproblem-solvingskills.

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